# The Oil and Gas Journal

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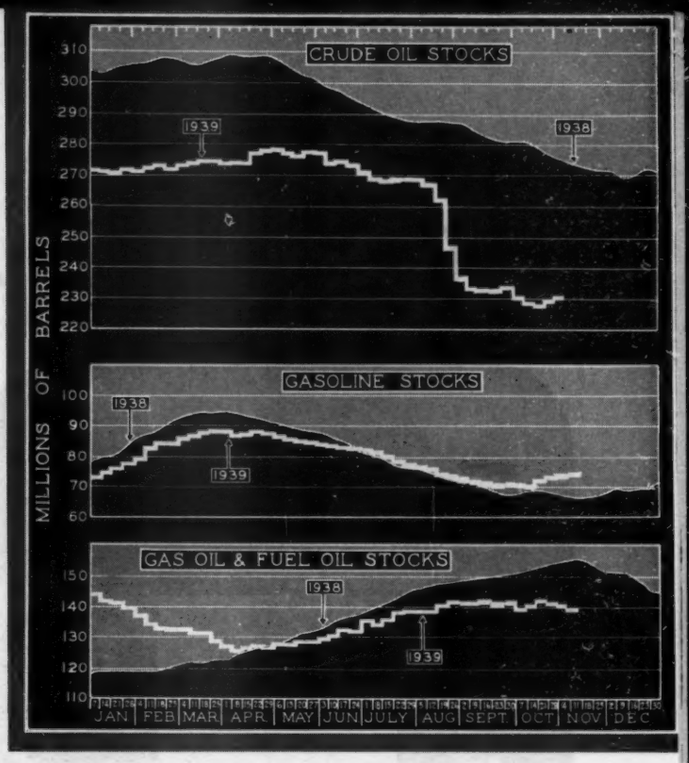
# Trends

## Local Crude-Price Increases Continue; Too Much Gasoline




AN increase of 291,093 bbl. per day in production of the United States in the past week was more than accounted for by gains in Texas, 261,949 bbl.; California, 23,500 bbl., and Oklahoma, 14,475 bbl. Production in Illinois showed little change, but a Devonian-lime test in the heart of the Salem field, which was near completion when this was written, was causing considerable concern to operators with their eye on the crude-price bulletin. If this well, or any future Devonian test in Salem, develops big production its influence on the future of the big field is plain to all. With no legalized regulatory body in the state, the exploitation of this formation might develop production that would swamp the pipe lines. A Devonian-lime producing horizon was uncovered last week in the Bartelso field, Clinton County, which drew added attention to the test in the Salem area. The Cole's Levee and Richfield Western fields in Kern County, California, were given a price schedule in the past week that was made retroactive to October 1. The prices start at $1 for 27-gravity oil and range upward to $1.61 for 46 gravity and over. Purchasers of Michigan crude oil increased the price of Bloomingdale and Columbia crudes in Van Buren County 5 cents per barrel, putting them on an equality with other high-grade pools in southwestern Michigan and increased West Branch-Ogemaw crude 3 cents per barrel.

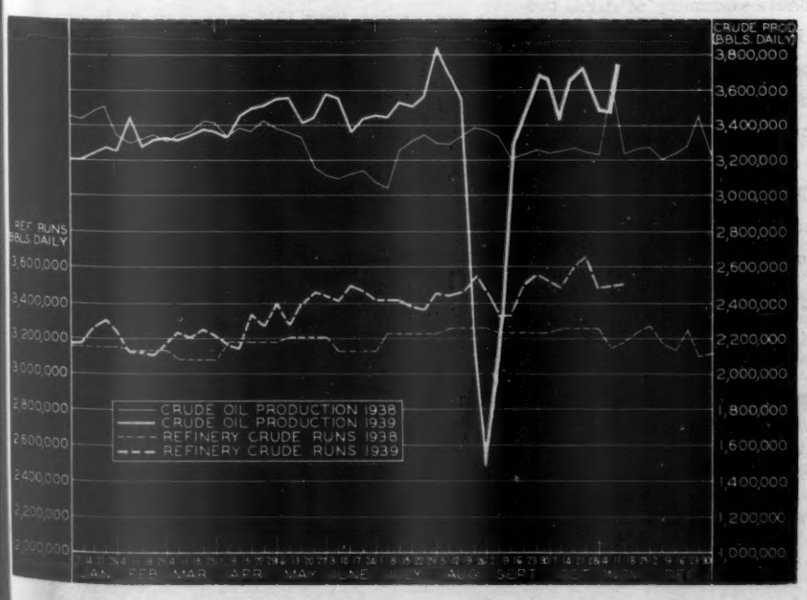
**CRUDE PRODUCTION** *3,789,117 bbl. daily average—up 291,093 bbl. One year ago 3,243,796 bbl.*

**CRUDE STOCKS** *230,994,000 bbl. as of November 4—up 541,000 bbl. One year ago 275,217,000 bbl.*

**GASOLINE STOCKS** *73,271,000 bbl. as of November 11—up 9,000 bbl. One year ago 69,372,000 bbl.*

**GAS AND FUEL-OIL STOCKS** *138,983,000 bbl. as of November 11—down 1,102,000 bbl. One year ago 154,666,000 bbl.*

**REFINERY RUNS** *3,536,000 bbl. daily week ended November 11 — up 71,000 bbl. One year ago 3,244,000 bbl.*


CRUDE PROD BBLS DAILY
REF RUNS BBLS DAILY
CRUDE OIL PRODUCTION 1938
CRUDE OIL PRODUCTION 1939
REFINERY CRUDE RUNS 1938
REFINERY CRUDE RUNS 1939

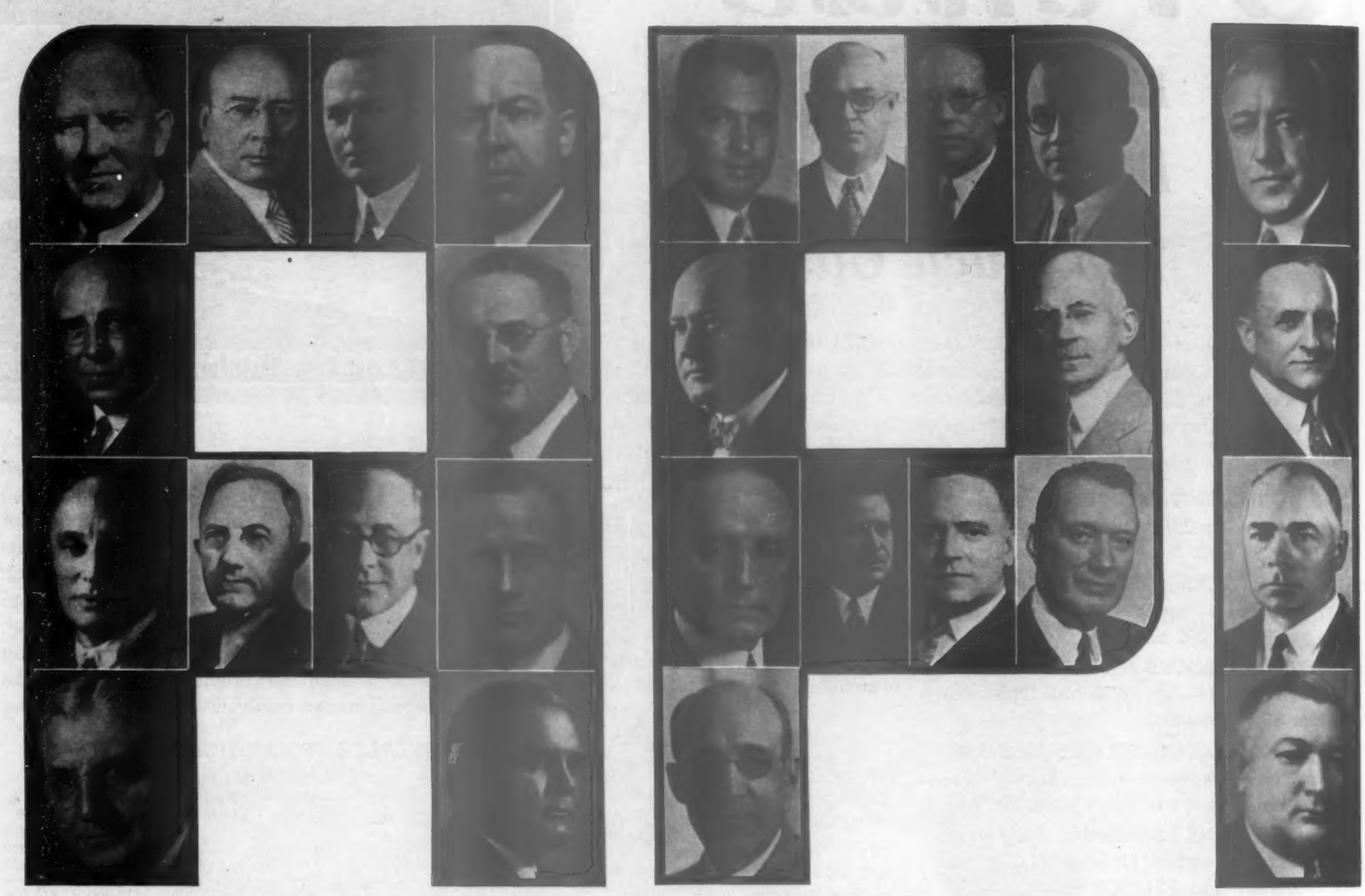
The Railroad Commission of Texas is being bombarded with petitions from operators in many pools for increased allowable production. Sixteen hearings are scheduled for this week and a number for next week, while in the last week the commission did little else than deal with such petitions. The commission has announced its intention to remain within the Bureau of Mines estimated demand.

Responding to colder weather, the heating-oil market went into higher gear. Gasoline continued to slip, as stocks rose to levels which many analysts believed out of line with probable demand. Also the wintry weather that stimulated the heating oils discouraged use of the family car. Congestion at Gulf refineries and terminals was relieved mildly by the lifting of a half-dozen cargoes of gasoline in coastwise trade, but there was small evidence of any improvement in facilities for trans-Atlantic movement. Lubricating oils and wax, which have been market leaders for weeks, were holding their gains, and in the Gulf Coast area lubricating oils were experiencing the most extreme tightness in years. Heavy industrial fuels continued their progress. Natural gasoline displayed an uncertain tone, although it was moving to Gulf Coast refineries in somewhat larger volume.

### *DAILY AVERAGE PRODUCTION FOR WEEK*

| | Nov. 11, 1939 | Bur. Mines Nov. est. of demand | Nov. state allowables | Nov. 4, 1939 |
|---|---|---|---|---|
| Oklahoma City | 105,900 | ..... | ..... | 87,275 |
| Seminole fields | 38,375 | ..... | ..... | 38,600 |
| Remainder of state | 285,250 | ..... | ..... | 289,175 |
| Total Oklahoma | 429,525 | 429,000 | 429,000 | 415,050 |
| East Texas | 495,193 | ..... | ..... | 396,092 |
| West Texas | 263,096 | ..... | ..... | 218,544 |
| North Central Texas | 129,750 | ..... | ..... | 109,346 |
| Texas Panhandle | 82,147 | ..... | ..... | 77,096 |
| East Central Texas | 95,698 | ..... | ..... | 85,390 |
| Gulf Coast Texas | 381,642 | ..... | ..... | 319,412 |
| Southwest Texas | 99,846 | ..... | ..... | 79,543 |
| Total Texas | 1,547,372 | 1,444,000 | 1,396,225 | 1,285,423 |
| North Louisiana | 65,815 | ..... | ..... | 64,990 |
| Gulf Coast Louisiana | 201,694 | ..... | ..... | 204,090 |
| Total Louisiana | 267,509 | 259,000 | 258,994 | 269,080 |
| California | 623,750 | 596,000 | 599,000 | 600,250 |
| Kansas | 164,900 | 169,000 | 170,600 | 173,250 |
| Arkansas | 68,970 | 57,000 | 68,952 | 66,800 |
| Eastern fields | 103,100 | 106,000 | ..... | 103,500 |
| Illinois | 328,959 | 303,000 | ..... | 326,580 |
| Michigan | 64,132 | 63,000 | ..... | 62,251 |
| New Mexico | 110,940 | 111,000 | 111,000 | 114,700 |
| Rocky Mountain area | 79,960 | 83,000 | ..... | 81,140 |
| Total United States | 3,789,117 | 3,620,000 | ..... | 3,498,024 |

# *Looking in on the*



***A.P.I. OFFICERS AND MEMBERS OF THE EXECUTIVE COMMITTEE.*** *First group, starting at bottom and reading clockwise: Edward G. Seubert, R. G. A. van der Woude, Henry M. Dawes, William F. Humphries, W. S. Farish, A. W. Jones, W. G. Skelly, John A. Brown, W. S. S. Rodgers, George A. Hill, Jr., vice president (production), C. M. Boggs, and W. H. Berg. Second group, clockwise from bottom: Frank Phillips, R. H. Colley, H. F. Sinclair, Jake L. Hamon, Charles F. Roeser, O. D. Donnell, B. L. Majewski, J. D. Collett, Baird H. Markham, John S. Cooke, and E. V. Weber, vice president (marketing). Third group, top to bottom: Axtell J. Byles, president; W. R. Boyd, Jr., executive vice president; J. Howard Pew, vice president (refining), and Lacey Walker, secretary and assistant treasurer*

CHICAGO, Ill., Nov. 17.—Next year will bring producers and refiners a new yearly record in demand for their products. Those who have made a study of 1940 petroleum requirements, including many of the industry's leading economists who are attending the sessions of the twentieth annual meeting of the American Petroleum Institute here this week, are in substantial agreement that fields and refineries in this country will be called upon to produce and refine more petroleum than ever before.

They cite a wide range of basic data in arriving at this conclusion. In regard to gasoline, the increase is predicated on the expectation that automobile companies in this country will manufacture and sell 4 million cars. If this materializes and the 1940 business level is the average of the year now being brought to a close, the domestic gasoline demand will show a gain of about 4 per cent.

It is pointed out that the total export and domestic demand is running 5 per cent ahead of 1938 so far this year. In regard to products other than gasoline, the 1940 demand outlook is at least as favorable as that of gasoline.

The estimates so far are based largely on probable developments in domestic markets. Statisticians are more hesitant in regard to export demands, due to the war. They can see possible shifts in the present war situation which would mean that a favorable domestic demand would be aided by sizable increases in shipments to foreign countries. This will depend, it is said, on how the war is conducted next year and whether there is any interference in the supplies to the belligerents from European and Asiatic sources. While this war demand is being determined, most economists are keeping their 1940 predictions as to exports around the average for 1938 and 1939.

**This 15-minute summary of A.P.I. proceedings is presented in three pages to give the reader the high points of the meeting. Addresses and technical papers appear elsewhere in the issue. Members of The Oil and Gas Journal staff in Chicago are: C. O. Willson, W. T. Ziegenhain, Dr. C. K. Francis, and L. M. Nichols.**

This favorable demand outlook for next year, and the increased operating activity of recent weeks, account for the heavy attendance at the Institute's meeting this year. The registration is exceptionally heavy from practically all of the oil states, with many here who are connected with operations outside this country.

Developments which had to do with governmental control of the oil business featured the general sessions this week. Spokesmen for the industry, whenever the opportunity was presented, reiterated their opposition to extension of federal control and their faith in regulation by states. However, there were developments within and outside the meetings which indicated that the threat of federal control has not been removed, with important developments in this matter probable during the coming year.

These general discussions took but a small part of the week, with numerous group sessions and committee meetings concerned with tax, public

relations, transportation, producing, refining and marketing practices under way, starting Sunday. The research and operating accomplishments of the industry over the past year as reflected in the proceedings of technical groups were outstanding.

W. R. Boyd, Jr., in place of Pres. Axtell J. Byles, who is not here due to sickness, formally opened the annual meeting Wednesday afternoon. The veteran executive vice president of the Institute took as his sole text the accomplishments of the industry as revealed in the recently completed investigation of the oil industry by the Temporary National Economic (O'Mahoney) Committee. He said that every major accusation against the industry has been answered, coupled with data showing competition and progress in conservation accomplishments. He concluded: "I am convinced that whoever heard the testimony from beginning to end, with open mind, must have gone away convinced both that this industry is typical of all that is best in the American system of free enterprise and that it is thoroughly capable of solving its own problems."

His pro-state and antifederal conservation-control views were supported by Gov. Leon C. Phillips, of Oklahoma. In his usual forceful language, the governor outlined the accomplishments of the industry under state control and gave his answers to those favoring federal intervention. It was apparent that the governor's views were in line with those of a filled meeting hall when he said: "I firmly believe that such legislation as the Cole bill imperils democracy as we know it. To turn over the oil industry to federal control and regulation under this bill is another step in the direction of collectivism, and collectivism is the bone and sinew of communism. This march toward government control of industry, labor and our free institutions must be stopped."

The congressional subcommittee which has started hearings on the bill for federal control will recommend the necessary legislation if it finds the present action of states is inadequate, Congressman William P. Cole told the general session Wednesday.

"There are those who believe that state regulation has failed in the matter of waste prevention," Mr. Cole declared, "but whether state regulation has failed to such an extent that the enactment of this legislation is necessary is a question on which I express no opinion at this time."

He quoted President Roosevelt as saying that while he preferred to see the elimination of oil and natural-gas waste through state action, federal laws would be necessary if the states failed to act.

The Maryland congressman pointed to the failure of Illinois and California to pass conservation acts and, regarding the discovery in Nebraska, said: "The whole story may repeat itself because the state has not passed regulatory measures and is not likely to do so once the race of competitive drilling gets under way. We have felt that the problem is not too big for the states, if they sincerely want to solve it; at the same time, the problem is not one which will tolerate abandonment or trifling by the states."

At another general session on Thursday, Dr. Joseph E. Pogue, a Chase National Bank vice president and petroleum economist, said so many are expressing views as to what is wrong with the oil industry that the real issues are "beclouded and distorted." He elaborated on his well-known position that the industry's conservation program should be based on engineering rather than economic criteria.

Axtell J. Byles, president, will continue to head the Institute's activities during the coming year. No changes are expected among the other officers and staff departmental heads of the organization.

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## Pipe Lines . . .

NO one test of corrosivity is best for all kinds of soil, said K. H. Logan, national Bureau of Standards, and E. A. Koenig, Magnolia Pipe Line Co., who emphasized the importance of studying the average corrosivity of a section of pipe-line right-of-way.

A method which has been successful in reducing the internal corrosion of a gasoline pipe line operated by Phillips Petroleum Co. was described by L. C. Morris and W. A. Schulze.

Any effort extended toward improving the efficiency and dependability of cathodic protection by the pipe-line industry should be the concern of the American Petroleum Institute, declared L. F. Scherer, Texas Pipe Line Co.

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# *Refining Methods . . .*

REFINERS and researchers saw another major step taken toward improving the quality of refinery products beyond that afforded by nature as a result of simple distillation of the crude oil. The group was introduced to the term "Petroleumization," which, according to the author, H. W. Field, Atlantic Refining Co., means combining and simplifying ordinary refining methods with new methods for synthesizing motor fuels and other products so that each is given a logical position in the industry. (See Page 110,)

Quite naturally, the manufacture of high-octane motor fuels commanded attention. The commercial production of 100-octane aviation gasolines received primary consideration in three papers. One described the production of commercial quantities of "neohexane" in a unit under construction at Borger, Tex. This material is a product of the thermal alkylation of isopentane and ethylene. The surprisingly favorable lead susceptibility shown by the material, and its low boiling range, appear to give it certain advantages over isooctane even though isooctane has an accepted octane-number rating of 100 and the new material is only 95.

Along with the development of thermal and catalytic alkylation, the refining industry learned more about the application and perfection of catalytic cracking, especially as carried out in the Houdry process. The practical application was most clearly understood when it was reported that Houdry catalytic cracking units in operation and under construction in the United States and France will have a combined charging capacity of 25,000 bbl. daily.

Recognizing the importance of conserving the octane value of the gasoline made by the various new processes those present were interested to learn that sulfur content seemed to suggest the lead susceptibility and the removal of sulfur under carefully controlled conditions promised to conserve the octane value and yet render the gasoline sweet and noncorrosive. For this work the industry learned more about the use of "solutizers" and "catalytic desulfurization."

●

# *Production . . .*

DETERMINATION of the optimum hole size will be a direct contribution to genuine conservation of petroleum, material and manpower in that the factors involved are, respectively, cumulative production to an economic limit, steel for wells, and drilling time, said Ernest K. Parks, Los Angeles. Well-completion practice is intimately associated with the proper selection of hole size but many unknown factors must be evaluated before the effect of the size of the hole on production performance can be determined.

A formula based on physical dimensions for the computation of load rating of roller bearings was presented by C. R. Athy, International Derrick & Equipment Division, International-Stacey Corp. Derivation of the formula, discussion of the factors involved, and life conversion factors were included in the paper.

Selection of material, surface preparation, correct application, and adequate film thickness are the four essentials for the successful protection of steel with organic coatings, declared C. F. Rassweiler, E. I. du Pont de Nemours Co., Inc.

Substantial confirmation of the validity of the plastic-collapse theory of tubes under external pressure was provided by J. L. Holmquist, National Supply Co., Spang-Chalfant Division, and A. Nadai, Westinghouse Research Laboratory. In the elastic case longitudinal compression stress or tension stress has no effect on the collapse pressure, while in the case of plastic collapse an axial compression stress raises the collapse pressure and an axial tension stress lowers the collapse pressure.

An equation for the determination of safe setting depths of pipe subjected to external pressure was suggested by W. O. Clinedinst, National Tube Co. Substitution of a "reduced modulus" for "Young's Modulus" in the usual elastic equation gave results nearer to the facts throughout the plastic as well as the elastic range, he said.

The most important characteristics of any gas-lift method are (1) back pressure held against the formation, and (2) gas consumption, said E. C. Babson, Union Oil Co. of California, who discussed comparison of the various methods and types of equipment and made suggestions for the application of gas-lift theories to production problems.

## Twenty-Five Year Club . . .

BANQUETING under horse-and-buggy-day scenes, with a kerosene lamp over the desk, brought back the oil office of yesteryear to 200 Twenty-Five Year Club members Tuesday night. They represented 67 companies and a combined service record of 6,333 years. The club was suggested a year ago by Dick Wotowitch. The president for the coming year is Allan Jackson, vice president, Standard Oil Co. (Indiana).

# Taxation--A.P.I.C. . . .

THE relationship of excessive taxation or diverted tax revenues to oil markets came in for discussion at several meetings sponsored by the American Petroleum Industries Committee, in charge of A.P.I. tax activities. Several sessions were devoted to programs sponsored by the A.P.I.C. with a number of speakers from all parts of the country.

Diversion to grain alcohol of 10 per cent of the consumption of crude oil away from the industry was only one of the methods by which pending legislative action might penalize the oil business, according to Conger Reynolds, chairman of the committee on motor fuels. A more serious problem, he contended, was that of converting the farm products from which it is made into alcohol at anything like the price people are now paying for gasoline.

"Oil men," he said, "know that manufactured alcohol from farm products would substitute raw materials, which fluctuate widely in value, for one which has a rather constant value. . . . Of course the dream chemists have been saying for years that power alcohol can be manufactured for 10 to 15 cents a gallon, but neither they, nor any one else, have done it.

"The oil industry is producing the best motor fuels possible at a lower level than ever before. The savings to the public in gasoline costs have been $1,500,000,000 per year compared with costs 10 years ago when gasoline was selling at an average price 7½ cents higher a gallon than at present. Also, a much better gasoline is being produced now."

Lamenting the fact that consumers are not receiving the benefits of these improvements in refining technique because of the practice of adding to the gasoline tax and then diverting a portion of the money away from the roads for which the tax is collected, Murray D. Van Wagoner, highway commissioner of Michigan, pointed out that at present 12 states are diverting gasoline-tax money and that $150,000,000 is annually going to outside uses.

Norman Tabor, consultant in public finance, stated that highway debts are proving to be motorists' burdens and that failure to pay for these roads and to maintain and amortize them means added new costs ahead. He advocated a "pay as you go" program for the states and said failure to do that by way of diverting tax moneys away from the roads could easily add 2 cents to the cost of each gallon of gasoline.

Francis Johnson, president of the Iowa Farm Bureau Federation, concurred in this statement and added that a practice of dividing the state funds among counties for covering expenditures other than road costs was making the gasoline-tax levies and appropriations a "pork-barrel" arrangement. This was recognized as serious and doubly so when Chester H. Gray, director of the National Highway Users Conference, reminded those present that the best highway will only last about 20 years and the nation is faced with a major highway-construction program.

"The country is in no condition to add to its financial burdens," was the position taken by Dr. Rosewell Magill, professor of law at Columbia University, when the matter of road construction costs was presented, he said the 1938 interest payments on our national debt total $926,000,000 or more than the total annual federal expenditures in 1915 and every year before that.

Baird H. Markham, director of the A.P.I.C., said: "Too many states and too many counties have borrowed money beyond their credits for road building. Too often these highways have been built without regard to their need. Many have been financed through long-term bonds. They will soon become inadequate and new ones will be needed long before the old ones are paid for. As a result, several states are faced with large bond maturities within the next 2 years and we may expect bond refinancing programs to become the order of the day." There were several other speakers on various phases of the taxation problem.

Dr. Gustav Egloff, in a lengthy discussion on gasoline grading, attacked the proposal of some states to include octane rating in their specifications. He said its adoption would lower the quality of gasoline and would tend to eliminate competition.

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## Public Relations . . .

THE public-relations program of the Institute over the past year has been largely devoted to the industry itself, Victor H. Scales, director of the Institute's public-relations department explained. The present program of the Institute got under way a year ago when a special fund was raised for the purpose. The department is operated similar to other departments of the organization, serving as clearing house for matters relating to public relations.

"It is obvious that when better understanding, impression and appreciation of this industry are created among its own people," Mr. Scales said in explaining the work within the industry of the past year, "we can expect a beneficial influence upon public opinion to develop almost automatically."

H. H. Anderson, of Shell Oil Co., Inc., offered a definite public-relations program for employers in their relations to employes. He recommended:

Recognition of employes as constituting a public entitled to sincere, fair and considerate treatment.

Development of a sound program of provisions and policies respecting employment.

Training of supervisory staff to carry out this program in the spirit which characterized its development.

Dissemination among the entire personnel of pertinent information as to the aims, history, operations and accomplishments of the company and the industry.

"This winning of public good will for the industry is a real job for its three-quarter million employes as well as its many thousand employers," Mr. Anderson concluded. "Each employer, small and large, should recognize and accept his full share of the responsibility to get results."

At a meeting of the public-relations committee this week a program and budget similar to the one in effect the past year was approved for 1940.

•

# Election of Directors

THE following 110 men today were elected members of the board of directors:

Production group, Pacific Coast—L. L. Aubert, Dana Hogan, R. A. Broomfield, L. P. St. Clair, Thomas A. O'Donnell, and William M. Keck, Los Angeles, Calif. Rocky Mountain—B. B. Brooks, Casper, Wyo. Central United States—Amon Carter, Fort Worth; R. L. Wheelock, Corsicana, Tex.; E. De Golyer, H. L. Hunt, Dallas; R. A. Landreth, Fort Worth; H. R. Straight, Bartlesville; E. H. Moore, Tulsa; J. S. Bridwell, Wichita Falls; E. L. Smith, Dallas; H. C. Wiess, Houston; J. A. Vickers, Wichita; Ralph Pryor, Wichita; Charles P. McGaha, Wichita Falls; Jake L. Hamon, Dallas, and E. H. Salrin, Houston. Eastern United States—F. A. Leovy, Pittsburgh; O. D. Donnell, Findlay, Ohio, and P. H. Curry, Pittsburgh.

Refining group, Pacific Coast—W. H. Berg, William F. Humphrey, and S. Belither, all of San Francisco. Rocky Mountain—T. A. Dines, Salt Lake City. Central United States—L. B. Simmons, Duncan, Okla.; Clyde M. Boggs, Arkansas City, Kans.; Roy B. Jones, Wichita Falls; D. J. Moran, Ponca City; T. H. Barton, El Dorado, Ark., and Alexander Fraser, St. Louis. Eastern United States—Charles L. Suhr, Oil City; H. A. Logan, Warren, Pa.; Paul G. Blazer, Ashland, Ky.; H. R. Gallagher and W. S. S. Rodgers, New York; Robert H. Colley, Philadelphia.

Transportation group, ships—J. Howard Pew, Philadelphia. Pipe lines—E. J. Henry, Philadelphia; Harry Moreland, Kansas City; D. S. Bushnell, New York. Tank cars—L. J. Drake, Chicago. Supply group—John A. Crawford and E. S. Dulin, Los Angeles; Alex Walker, Toledo; W. M. Bovaird, Tulsa; E. W. Gildart, Beaumont.

Marketing group, Pacific Coast—Reese H. Taylor and Charles S. Jones, Los Angeles; H. D. Collier, San Francisco. Rocky Mountain—W. H. Ferguson, Denver. Central United States—K. S. Adams, Bartlesville; W. G. Skelly, Tulsa; B. L. Majewski, Chicago; I. A. O'Shaughnessy, Minneapolis; Henry M. Dawes, and E. G. Seubert, Chicago. Eastern United States—C. E. Arnott, New York; W. V. Hartman, Pittsburgh; W. E. Smith, Louisville; W. T. Holliday, Cleveland; E. W. Sinclair, New York.

Natural-gas group—J. D. Creveling, New York; N. C. McGowen, Houston.

Natural-gasoline group—W. K. Warren and D. E. Buchanan, Tulsa.

Twenty-five members of the board of directors to represent the industry as a whole: C. J. Backdull, Chicago; Wirt Franklin and Frank Buttram, Oklahoma City; R. van der Woude, Earl W. Webb, Harry D. Frueauff, and J. A. Brown, New York; William N. Davis, Bartlesville; S. A. Guiberson, Dallas; J. C. Hunter, Abilene, Tex.; Charles F. Roeser, Fort Worth; Eric V. Weber, Cincinnati; Jacob France and E. B. Reeser, Tulsa; T. Rieber, New York; J. F. Lucey, Dallas; John M. Lovejoy and A. Jacobson, New York; B. F. Harris, Pittsburgh; Frank Phillips, Bartlesville; George A. Hill, Jr., Houston; J. Frank Drake, Pittsburgh; W. S. Farish and H. F. Sinclair, New York.

The board of directors selected Fort Worth for the midyear meeting next May. The annual meeting in November 1940 will be held in Chicago.

The board approved a resolution for appointment of a committee to conduct a census of oil wells. It also appointed a committee to serve with one representing the Independent Petroleum Association of America which will consider the segregation of integrated-company earnings. The Institute members are J. Edgar Pew, W. S. Farish, W. S. S. Rodgers, J. Frank Drake, and E. G. Seubert.

The board adopted a resolution in memoriam on the death of J. W. Van Dyke.

# Boyd Analyzes T.N.E.C. Inquiry Into Industry

By W. R. BOYD, JR.
American Petroleum Institute, New York

THROUGHOUT the oil industry interest largely has been centered the last few weeks on the hearings at Washington before the Temporary National Economic Committee in its inquiry into the petroleum business. So it would seem appropriate that somebody who attended those hearings should make at this time an informal report on them. The newspapers, with their interest and space commandeered by the war in Europe and the neutrality debate in Congress, were unable to give such satisfactory reports as we might have expected in other circumstances. On the other hand, I think compliments are due to the trade press of our industry for the intelligent manner in which it covered the news of this big event in petroleum history.

The membership of the T.N.E.C. includes representatives of the House and Senate and of the Departments of Treasury, Justice, Labor, and Commerce; of the Federal Trade Commission, and the Securities and Exchange Commission. All the administrative agencies thus represented have contacts with the industry by reason of their duties as administrators of various laws affecting it; all of them had in their possession a good deal of data regarding the industry, which had been studied carefully in anticipation of the hearings. Exhaustive questionnaires had been sent to the companies and industrial associations; and, from the replies, extensive summaries and tabulations had been prepared.

Complaints and criticisms had been studied, and the people who had lodged them with the government agencies were afforded opportunity to tell their stories.

**Testimony at the T.N.E.C. hearings damaged two theories: one that so-called majors are united in a war on independents; the other, that price leadership of a few big integrated companies implies monopolistic control. Divorcement of marketing from refining companies would set up the very kind of monopoly that was denounced. Apparently demonstrated that conservation demands proration.**

### Institute and Industry Witnesses

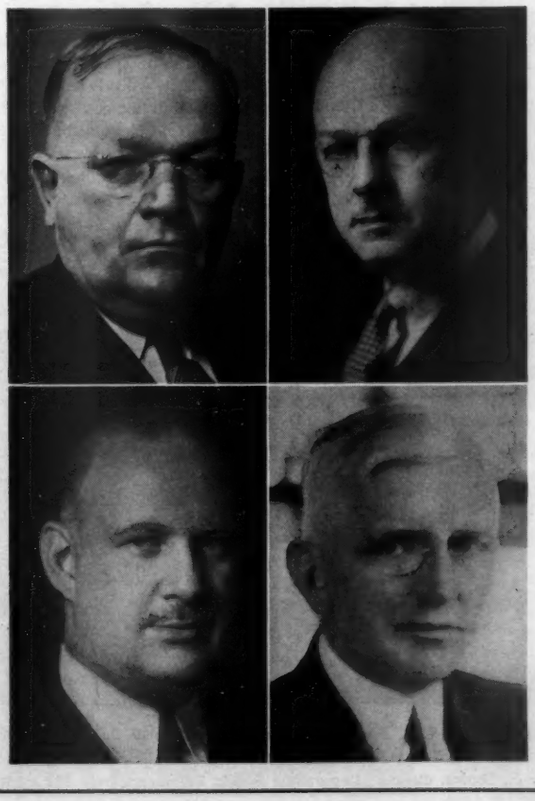
On the other hand, the American Petroleum Institute, as an inclusive trade association of the industry, had been invited to mobilize and present the facts on behalf of the industry. The various departments of petroleum-industry activities were assigned for analysis and discussion to men whose position and experience particularly qualified them for the task. All of these men devoted time and energy for many weeks to preparation for the hearing. To them are due the acknowledgment and appreciation of everybody who is concerned for establishing in the public mind an adequate conception of the industry. Frankly and fully, they pictured its problems, its services, its vital importance to the national welfare, and the relations which should subsist between it and the agencies of government, both state and federal.

On the part of both the committee and the Institute's witnesses, there was evident desire to bring out the facts, fairly and objectively. Frankness and good temper were the rule. On the committee side of the table, urbanity rather than the truculence of the prosecuting attorney characterized the questioning; witnesses were not made to feel that they were defendants.

### A Comprehensive History

As a result of nearly five weeks of hearings in such an atmosphere, a record was made on which I believe both the committee and the industry may stand well satisfied. In print, as a government document, it will cover I should hate to guess how many thousands of pages; but it will be a real library of the industry's history, development, and outlook on the future. No matter how well you may think you know your industry, this report will contain a lot of education for whoever is willing to know more.

Any attempt adequately to summarize such a document would be a labor of Hercules; and the summary would run to so great a volume that it could not be presented here. Likewise, any effort to analyze its ultimate effect on the collective mind of the Temporary National Economic Committee would be in bad taste and of small value. Prejudices and preconceptions are bound to enter into the evaluation of such a mass of material. To eliminate the trivial and unimportant, to reconcile contradictions, to assign proper weight and significance to all the elements, will be a task worthy of the widest industrial experience and the soundest economic thinking. The eye of hostility easily will find justification for criticism and for the application of radical governmental policies. On the other hand, the vision which is determined to discern no basis for criticism, no opportunities for improvement, will find ample support for its judgment that the industry is as nearly all right as any industry could be in a somewhat imperfect world. If the inquiry shall



## A QUARTET OF THE SPEAKERS AT THE GENERAL SESSION

Top: Gov. Leon C. Phillips, Oklahoma, declared there is no need for federal regulation.

Dr. Joseph E. Pogue urged transfer of emphasis from economic to engineering criteria.

Lower: Victor Scales asked every unit to join in public-relations programs.

Congressman W. P. Cole sponsored federal regulation bill.

be made the springboard from which to project new proposals in governmental policy, I think we fully are justified in hoping that these proposals will be thoroughly considered and sincerely constructive.

### Intense Competition

There was a notable absence of the old-time prejudice that too long survived from the epoch of the old Standard Oil Trust domination. The occasional critics who charge that something like that old domination still persists, in the form of collusive arrangements among the "big companies," will find little support of their theory in the picture that has been drawn of keen and relentless competition among those same "big companies." The present-day proponents of the monopoly accusation seem to be divided into two groups. One group charges that some 20 or 25 so-called "majors" are somehow united in a war against all the rest of the companies, designated as "independents." The other group of monopoly hunters have a theory that the "price leadership" of a few big integrated companies in their various territories gives a measure of control that savors of monopoly. Both these theories would seem to have been broken down pretty thoroughly by the mass of evidence that these alleged conditions simply don't exist. It was made very plain that, on the one hand, the 20 or 25 "majors" are too busy competing with each other, and that, on the other side, the so-called "price leaders" constantly are having their leadership challenged, and frequently defeated. On the whole, the testimony suggested that excesses of competition, rather than tendencies toward monopoly, are most characteristic of the industry.

### Divorcement Disastrous

The demand for divorcement of pipe lines plainly had made considerable impression on some members of the committee in advance of the hearing; but the reasons against it were presented so ably that at the conclusion there seemed little likelihood that the committee could find justification for such a recommendation. Likewise the arguments in favor of divorcement of marketing obviously had claimed considerable of the committee's interest among the committeemen. But in this case, again, the opposition presented so strong an array of arguments against it that at the close there seemed small possibility of finding reasons for favoring it. In fact, the evidence was pretty conclusive that to divorce marketing from the refining companies would have the effect of setting up the very kind of a monopoly that some members of the committee had been led to believe existed. As to both pipe lines and marketing, in the final analysis it was made plain by the Institute's spokesmen that divorcement would be disastrous, and that it was opposed by the overwhelming majority of the industry. As to neither proposal was there any evidence of public support or consumer interest. In fact, throughout the hearings the absence of consumer complaints was a particularly gratifying circumstance. Nobody appeared to find fault with the prices he paid nor the services he received.

The development of conservation policies and practices in recent years was gone into in much detail. An effective picture was drawn of the great progress in eliminating oil-field waste on the one hand and, on the other hand, in recovering constantly greater percentages of the more valuable products from the crude. In these regards, and especially as to oil-country conservation and prorationing, the record will be found to present a vast amount of material that will be as illuminating to people in the industry as it will be to legislators and public administrators. We believe it was demonstrated clearly that conservation cannot be accomplished without prorationing.

### Interstate Compact Favored

The rapid increase in the nation's proven reserves of petroleum, with its assurance against the old-time alteration of feast and famine, and its promise of progressive stabilization throughout the industry, effectively was set forth. In this connection, the minority who have been advocating federal control, instead of decentralized regulation by state authority and common council under the interstate oil compact plan, since the hearings have received a sharp setback at the hands of President Roosevelt. On the morning of the last day of the hearings the newspapers carried a statement by him in favor of the interstate oil compact which must be rated as of first importance. The President made his pronouncement at his morning press conference in response to a question of a news correspondent. The Associated Press dispatch said:

"WASHINGTON, October 24.—President Roosevelt endorsed once more today the principle of controlling America's oil production through state compacts.

"In response to press-conference questions, he asserted that several years ago he favored that principle, and felt it should be given ample opportunity to see whether it would work. The alternative to control through agreement among the states, he said, is federal regulation, which he prefers to avoid.

"While the compact method has not been wholly successful, the president said, it is felt that it can be made a success."

This statement, coming from the president after the case for the interstate compact had been set forth by both the spokesmen of the industry and the chairman of the Interstate Oil Compact Commission, seems highly significant. If there ever has been an idea in the president's mind of substituting federal control for compact regulation, that idea would seem to have been dropped. The spokesmen for the industry did not claim that the compact method was yet operating with 100 per cent effectiveness. They did, however, demonstrate convincingly that great progress has been made; that results thus far have been such as to justify confidence in the plan; and that there is every reason to expect still better results with time, experience, and the adherence of more states to the compact. A sympathetic attitude at Washington toward the compact plan certainly is calculated to allay fear of attempts to enforce sweeping federal rule. . . .

Such criticisms as were presented, throughout the hearing, when viewed against the background of the industry's size, its rapid growth, its large requirements of capital, its long record for high wages to workers and low prices for products, and its success in meeting all demands upon it, inevitably appeared trivial by contrast with the splendid record of achievements. I am convinced that whoever heard the testimony from beginning to end, with open mind, must have gone away convinced both that this industry is typical of all that is best in the American system of free enterprise, and that it is thoroughly capable of solving its own problems.

## Safety Certificates Awarded

CHICAGO, Nov. 15.—Thirty-seven award certificates for accident-prevention records by oil companies in 1938 were awarded today. The 1938 records covering 317,000 employes of 144 companies in all branches showed a 13.4 per cent decrease in injury frequency and a 4.8 per cent decline in injury severity.

Natural-gasoline divisions of three companies had no lost-time accidents, Gulf, Continental and Hope Construction & Refining Co. Continental also won an award for the best safety record in all departments, with Gilmore Oil Co., Los Angeles, second.

Refining: Standard of Indiana, Mid-Continent Petroleum, Wadhams Oil Co., Barber Asphalt Corp., and Stanolind Oil & Gas Co.

Marketing, wholesale: Gilmore Oil Co., Magnolia, and Texas Pacific. Marketing, retail: Cities Service, Standard of Nebraska, Smith Oil & Refining Co. Marketing, wholesale and retail: Continental, Tide Water Associated, Charleston Oil Co.

Drilling: Ohio Oil Co., General Petroleum Corp., Humble, Globe Oil & Refining Co., Continental, Republic Production Co. Production: Chanslor-Canfield Midway Oil Co., Republic Production Co., and Globe Oil & Refining Co.

Pipe line, oil: Atlantic Pipe Line Co., Stanolind Pipe Line Co., Mid-Continent Petroleum, Arkansas Natural Gas Corp., Lion Oil Refining Co. Pipe line, gas: Peoples Natural Gas Co., Panhandle Eastern Pipe Line Co.

Marine: Tide Water Associated and Atlantic Refining.

*A.P.I. DIVISIONAL AND DEPARTMENTAL HEADS: Dr. R. P. Anderson, secretary, Division of Refining; C. A. Young, secretary, Division of Production; H. N. Blakeslee, director, Department of Accident Prevention; Fred Van Covern, director, Department of Statistics, and D. V. Stroop, director, Department of Engineering. Not pictured here but shown elsewhere are Victor H. Scales, director, Department Public Relations (Page 81), and Baird H. Markham, director A.P.I.C. (Page 78)*

# Cole Bill Is Branded as Step to Communism

By LEON C. PHILLIPS
Governor of Oklahoma, Oklahoma City

**A.P.I.—Extracts from paper before annual meeting, Chicago November 13-17**

IS there any good reason why some federal official now should survey the field and propose a bill to take over your industry? Can that attempt be anything but a longing grasp for more power? Why should the suggestion even be raised?

We have seen the commingling of federal employees in the boards of directors and boards of control of the corporations of some of the European countries. At first the Government controllists wanted only a fifty-fifty voice in the control of the industries of those nations; then they wanted the majority; and later they took over entire control of the business of the nation, and a dictatorship followed. But I shall not attempt to tell you more about conditions abroad; for we have enough to occupy our attention here at home. . . .

It is unnecessary for the federal Government to undertake to do what the states are doing already, and have demonstrated they are able to do—prevent avoidable waste in the production of oil. The states do this under their inherent police power. The federal Government has no police power. . . .

There is no new conservation principle in the Cole bill. It merely incorporates principles discovered by the oil producers themselves. By its terms, the bill is an unqualified endorsement of the methods and practices invoked by the oil-producing states in their conservation laws, and recommended by the Interstate Oil Compact Commission. But, like many modern laws, it sets up an appointive official with despotic powers. This official is given the right to enact legislation by merely prescribing rules and regulations. . . .

It is conceivable that the state, in the exercise of its sovereignty, would prescribe certain regulations; while the commissioner, the federal authority, employing a different set of engineers and experts, would prescribe different rules. The producer then would be in a dilemma: If he ignored the federal rule and observed the state rule, he would be subject to heavy penalty. If he ignored the state rule and obeyed the commissioner, he would be subjected to the penalties provided by the state. Thus, it is probable that he would experience difficulty in faithfully serving two masters. The provisions of the law whereby the federal commissioner may cooperate with the state authorities is optional with the commissioner. He is "authorized," but not "directed," so to do. A real conflict of authority would be inevitable, unless the Cole bill should be amended so as to deprive the states of their police power, and the Supreme Court should sustain such a law. In that event, the states would lose all jurisdiction. That would be a complete surrender of state sovereignty. . . . .

The commissioner is empowered to file a written complaint against a person, before himself; and, after five days' notice, try the accused and make findings against him, and issue a desist order. The accused has the privilege of appearing in person, or by counsel, to present evidence under regulations prescribed by the commissioner. The rules of evidence prevailing in the courts are not controlling in such hearing. The judgment of the commissioner is conclusive in all courts, if supported by substantial evidence. The commissioner is permitted to fix the time and place of this hearing. It is obvious that it would be most convenient to the commissioner to have such hearings in Washington, D. C. The only appeal allowed the accused from the ruling or order is the the Circuit Court of Appeals. It is provided, however, that this court is bound by the findings of the commissioner, if supported by substantial evidence. The commissioner may enforce his rules and regulations by injunction or mandamus in any federal District Court, without bond. The bill, conveniently, provides that the District Court of the District of Columbia shall have jurisdiction of such suits and persons. Civil or criminal proceedings may be instigated by the commissioner in any state of the nation.

By the terms of the bill, the commissioner is vested not only with legislative, judicial, and executive power, but he is granted broad discretionary powers. Repeatedly the bill uses the words: "The commissioner is authorized and empowered"; but nowhere is he "directed." It truly may be said that the powers granted to the proposed commissioner are dictatorial. . . .

We have too many who run to the Government with their problems, instead of facing and solving them by their own industry and effort. Throughout the land we have crackpot schemes

*AUTHORS—First row: C. F. Rassweiler and A. T. McDonald*

*Second row: S. H. McAllister, E. R. White, L. C. Morris and L. A. Blanc*

*Bottom: John R. Bates, A. V. Caselli, Ben W. Sewell and A. G. Peterkin*

and impractical Utopian ideas. Let's stop enslaving ourselves by asking the Government to do for us that which we can do. Any nation that rewards indolence, encourages extravagance, and discourages thrift and enterprise is doomed. . . . .

When we look at governmental regulation of business, can we say it will improve the lot of these American citizens, engaged as they now are in private employment? Can we expect the administration of our oil fields by the Government to be better than its agricultural efforts have been in my State of Oklahoma? In my state the small farmer has been driven from the land to the W.P.A. rolls, and we see now that the Government experts are not all-wise. Can we point with pride to Government regulation of the railroads? Will we shut our eyes to the fact that they are now almost wholly dependent upon advances by the Government? Do the results of Government regulation of the coal industry tempt us to get under cover of Government control in order to perpetuate and safeguard the future of these millions of Americans we have been talking about?

When we take this survey and look at modern legislation, we see the plain intent to gain control of everything and everybody. Are there some of you who will try to gain some favor through acquiescence in federal control of oil, on the theory you can continue—and perhaps even reach—this arbitrary power and get what you want? I say to you, it will never work.

Big business needs the support of little business, and all capital and labor need to cooperate on a give-and-take basis in order that the nation may be guaranteed in future years the honest employment of its citizens by private enterprise, and likewise to discourage further government employment and control of American citizens. When big business chokes out little business, and the Government chokes out big business, our ideals and our democratic theory of government will come to an end.

To turn over the oil industry to federal control and regulation under the proposed Cole bill is another step in the direction of collectivism—and collectivism is the bone and sinew of communism. . . . "

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# Chairman Cole Neutral on State Regulation

CHICAGO, Nov. 15.—Congressman W. P. Cole, chairman of the oil subcommittee, addressing the A.P.I., said proponents of federal regulation believe that regulation of oil production by state conservation laws was bound to fail and the federal Government must step in to legislate in the "no-man's land" between present state and federal legislation.

"There are those who believe that state regulation, after a reasonable period of trial, has failed in the matter of prevention of avoidable waste to the degree the nation should expect, and is not likely to prove effective in the future. But whether state regulation has failed to such an extent that the enactment of this legislation is necessary is a question on which I express no opinion. Perhaps our committee will be able to form an opinion."

Mr. Cole said California and Illinois found many difficulties attending attempts at state regulation, and, citing recent discovery of producing wells in Nebraska, he added: "The whole story may repeat itself because the state has not passed regulatory measures and is not likely to do so once the race of competitive drilling gets under way."

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# More Power for Autos

SPECTACULAR advances in automotive power were predicted by Dr. Graham Edgar, vice president and director of research of Ethyl Gasoline Corp., in an address at the annual dinner of the Institute of Petroleum Wednesday night. Developments which will give the automobile driver 50 per cent more mileage to a gallon are foreshadowed by experiments to determine the possibility of increasing compression ratio under conditions in which the antiknock value of the fuel is no longer the limiting factor.

Supercharging opens another field of opportunity for utilization of fuels of high antiknock value by the automobile engine.

*DR. GRAHAM EDGAR*

"The automotive engine is fully capable of utilizing the best fuel that the oil refiner can make available," Dr. Edgar declared, but no one can yet tell what this fuel will be. The development in the refining art will be gradual because of the magnitude of the industry. "No matter how valuable a new refining process may be, considerable time must elapse before it can play a substantial part in the industry.

"A corresponding gradual increase in the quality of the marketed products, with no apparent limit on this quality, and in the efficiency of the automotive engine may likewise be expected."

*AUTHORS—Top row: Dr. Gustav Egloff and William D. Humphrey. Second row: D. V. Barnard IV and Walter A. Schulze. Third row: H. H. Anderson and W. O. Clinedinst. Fourth row: D. L. Yabroff and A Nadal. Fifth row: Howard J. EnDean and T. J. Crawford. Sixth row: B. H. Sage and John L. Holmquist*

# Suggestions Offered To Allay Criticism

By JOSEPH E. POGUE
Chase National Bank, New York*

THE striking thing about all recent findings is the virtual absence of criticism directed at the industry as a whole, and the recurrence of protests against internal competitive practices. No fault is found with the service rendered to the consumer and with the relations of the industry to its personnel. But in respect to procedures within the industry—the handling of economic traffic across departmental frontiers, the administration of the proration-conservation function, and the competitive struggle between contending groups—here interest converges and objections focus. It is important to examine the validity of the criticisms, but it is still more necessary to appreciate that they are widely publicized and often accepted as valid indictments. The crux of the matter is that the industry has permitted these discords to flourish and to become translated into political threats which may have regressive effects upon its progress and its contributions to the economy.

The complaints and grievances voiced against the competitive practices within the petroleum industry may be summarized and grouped under six headings, as follows:

1. Proration is primarily a price-fixing measure, operated under the guise of conservation, which works to the disadvantage of the small operator and the independent refiner.

2. The predominance of large companies in the oil business limits the opportunities for small enterprises.

3. Refinery ownership of pipe lines confers an unfair competitive advantage upon companies so equipped.

4. Integration permits the profits in one division of the business to be used for subsidizing competition in another, to the disadvantage of nonintegrated competitors.

5. The field of marketing is beset with competitive practices that unduly restrict the opportunities of independent jobbers and retailers.

6. Pricing policies for both crude oil and products are confusing, and favor the large units. . . .

These complaints are not concerned with conditions touching the interests of the public, but relate to circumstances within the industry that exert differential pressures upon competing groups. No well-grounded objections are included which the industry itself is not in a preferred position to clear away. The customary panaceas advanced—such as governmental intervention or industrial disintegration—are of a severity out of proportion to the gravity of the issues, which are merely incidental maladjustments in a rapidly changing industry, and do not call for improvised or disruptive action. To avoid such action, however, it is essential that the petroleum industry cultivate a more pervasive sense of social values and adjust the frontiers of competition to the requirements of economics and the dictates of social welfare. To this end the following six suggestions are offered covering policies for the most part now being followed, but the furtherance of which should be expedited, in order not only to remove the sources of existing grievances with their political repercussions, but also to carry forward the operations of this great industry to a position of even higher value to the economy.

1. Accelerate the transition from proration guided by economic criteria such as market demand to proration grounded in engineering standards such as optimum rates, thus furthering the objectives of conservation and minimizing the delegaton of economic power to regulatory bodies.

*From Dr. Pogue's address on "The Frontiers of Competition in the Petroleum Industry." For assistance in the preparation of this paper, the writer is indebted to Dr. Norman D. FitzGerald, Department of Petroleum Economics, Chase National Bank.

**A.P.I.—Extracts from paper before annual meeting, Chicago November 13-17**

2. Promote a greater awareness of the implications of the common-carrier status of pipe lines, and facilitate the adjustment of their economic function to the social responsibilities imposed.

3. Further the movement of publicity efforts from the plane of explanations and justifications for what has been done to the level of planning to prevent the development of disparities leading to subversive criticisms.

4. Expand the technique of refinery management by anticipating demands and adjusting prices and yields to conform more closely to future requirements, thus sensitizing the response of operating schedules to business conditions, so that inventories can be more accurately balanced and maintained at economic levels.

5. Recognize more fully the functional aspects of prices and margins in regulating the flow of capital into marketing, and inhibit additional investments in this field until a better balance is attained, avoiding unwise incursions upon business adequately served by existing enterprise and recognizing the advantages of healthy competition in establishing economic boundaries.

6. Facilitate the pricing of both crude oil and its products on a more sensitive and basic technique, reflecting economic changes promptly and in graduated measure, in order to conserve equilibrium not only in operating conditions but also in the flow of capital into investments.

*AUTHORS—Top row: Thomas P. Simpson and G. G. Oberfell. Second row: Fred E. Frey and R. C. Alden. Third row: W. N. Lacey and Lewis F. Scherer. Fourth row: H. W. Field and Ernest K. Parks. Fifth row: Aristid V. Grosse and J. W. Payne. Sixth row: Conger Reynolds and Paul G. Exline*

*Centrifugal pump driven by a steam engine and duplex pump used to remove water from the crater, jet lines and capped well*

# Greta Cratered Blowout Is Finally Conquered

By NEIL WILLIAMS

HOUSTON, Tex., Nov. 13.—After 8 months of difficult and tedious efforts, involving unusual engineering undertakings, M. M. Kinley Co., of Houston, has been successful in bringing to an end the 3½-year rampage of Missouri Pacific's cratered blowout well in the Greta field, Refugio County, Texas Gulf Coast. Cemented to the top, and with bull plug screwed on, an operation concluded November 4, the well now is considered completely and permanently killed and plugged.

The well, drilled by the National Development Co., now defunct, blew out in May 1936. It cratered quickly, and, located in the railroad right-of-way, soon engulfed the railroad tracks on one side and the concrete highway on the other. Fortunately, the well, at a depth of only approximately 4,000 ft., had not reached the main oil-producing sand, and its output has been limited to salt water and gas.

Prior to Kinley company's taking over the well two other attempts had been made to kill the blowout. One involved a directional well, and the other a vertical relief well. Both failed, due to very little information being available concerning the sands, or the depth from which the blowout occurred.

The Kinley company took over the well on the speculation that casing remained in the hole and that by pumping the crater dry this casing could be reached and the well capped. Pumping was started late in February, the first pumping installation consisting of a centrifugal mud pump powered by a steam engine. This pump, in the beginning, put out an 8-in. stream estimated at 1,500 bbl. an hour.

Due to the water in the crater being very salty, about 3,600 grains per gal., provision first had to be made for its disposal. It was necessary to confine the water to the railroad property.

When pumping was begun, the water level was at an elevation of 61.2 ft. The well, according to fairly accurate gaging, was making approximately 500 bbl. of salt water hourly, which the single pump at its initial capacity could easily keep ahead of and at the same time handle an additional 1,000 bbl. hourly. Considerable trouble was experienced at first, with grass roots, sisal, sticks, and scraps of burlap bags getting into the pump, causing delay to clean out the suction pipe.

To confine the flow and minimize the wave action in the crater an attempt was made on March 7 to place a stack over the flow. A stack was made out of a 50-ft. section of 16-in. pipe, welding on to one end a 4-ft. square funnel. Dead men were set on four sides of the flow in the crater for anchoring the funnel. A cable was strung across the crater, and on a traveling block the funnel was swung over the flow, but due to the debris, concrete, riprap, pipes, railroad rails and derrick parts, it was found impossible to land the funnel-stack effectively, and the strong gas pressure made it impossible to hold it in place.

About this time it was found the pump was about worn out and the water level was gaining on it, so the pump was pulled for overhauling. With it, however, the water had been lowered to 17.6 ft. above sea level, leaving about 8 ft. of water in the crater, the inner crater at that level being about 95 ft. in diameter.

By March 24 the water was lowered to 14.2 ft. above sea level, where pipe and debris began showing up. This was pulled away. Two days later, despite some pump trouble, the water level was down to 3½ ft., where the diameter of the crater was 30 ft. At that depth, with the hydrostatic head reduced, the gas was shooting water 70 ft. high and throwing large rocks.

The well ignited several times and was extinguished each time with considerable difficulty. A weighted stack was finally placed over the flow and an unsuccessful attempt made to cement it.

Cementing efforts were abandoned when it started to rain, which washed sand back into the crater, filling the crater to 7½ ft. above sea

level, or 6 ft. above the level to which the water had been lowered.

An attempt was made to fill the sand with cement to form a monolithic block of concrete around the stack. Using a Halliburton cementing pump, 150 sacks of cement slurry was jetted into the sand through a 2-in. hose. This failed.

Next, after probing with a 1-in. pipe and determining the gas was blowing through the drill stem still in the hole, an attempt was made to set a 10-in. pipe over the drill stem. This first attempt was unsuccessful. Following this, 300 sacks of cement slurry was pumped through the mass of 2-in. pipes which had previously been jetted into the sand.

It then was decided to rig up a rotary outfit to mill down through the debris in an effort to get the 10-in. pipe down to or over the old casing. Milling began June 9 and by June 11 the operation had been successful in milling down 4 ft. below the bottom of the stack, which was 5 ft. below sea level. Unable to make further progress in milling, a shot of eight sticks of gelatin was placed inside the stack, which blew out some tie plates, pieces of pipe, concrete fragments, etc. Milling was resumed and it was possible to drive the 10-in. pipe to a point 8 in. below the top of the flow. This was cemented in place and all of the flow directed through the 10-in. pipe.

Efforts to cement between the original cement at the top of the stack and the bottom of the stack failed as the flow through the 10-in. pipe sucked the cement from the space between the 10-in. pipe and the 16-in. stack and blew it out with the gas and water. The bottom of the 10-in. pipe was 68.7 ft. below the original water level of the crater, or 7½ ft. below sea level. At this time one mud-hog pump was able to keep the water out by pumping about 300 bbl. per hour.

### Pumping Out Sand

Next, it was necessary to pump the accumulated sand out of the crater to expose the top of the 13-in. surface casing. To provide sufficient water for pumping this sand, arrangements were made to pump the crater fluid into a lake and allow the clear water to run back into the crater to be used for circulation. A new and larger (11-in. by 11-in.) steam engine was obtained to provide adequate power to handle the sand. Considerable pump trouble was experienced and a number of delays were occasioned because of repairs and replacements to equipment, but by August 17, all sand was pumped out of the crater. Approximately 12 ft. of caliche remained to be excavated. Considerable trouble was experienced during excavation due to caving sands and strong freshwater springs uncovered. A mass of matted pipe, iron and junk, all cut into short lengths by action of the gas flow with the sand, was found at the base of the stack.

At a depth 9 ft. below sea level the junction of the 10-in. pipe placed over the drill stem, and the 8-in. casing of the well was exposed. As digging continued additional large quantities of scrap iron and some heavy pieces of equipment were encountered, all of which had to be removed. Because of badly caving banks it was necessary to drive sheet piling. Then a 16-in. clamp was set around the junction of the 10-in. pipe and the casing, loosely, so it would follow the excavation downward. At the same time the stack was lowered 18 in. When the 13-in. conductor pipe was exposed it was found that the 10-in. pipe was riding on top of it, and also that the top of the 13-in. conductor pipe was too jagged to get the 16-in. clamp over it. Consequently, a metal oil drum was cut down the side and opened so it could be clamped over the junction of the 10-in. pipe and the 13-in. casing, and this was filled with concrete. Four cubic yards of concrete was poured around the bottom of the stack and the oil drum, as a monolithic block of considerable size and weight to reinforce the joint.

The 15-in. blow-off pipe was removed and the 10-in. pipe withdrawn from the stack. The bottom of this 10-in. pipe was very badly eroded about 3 ft. The rotary shoe was not recovered. When this 10-in. pipe was removed a large volume of sand began blowing through the stack and an occasional rock about the size of the gravel used in the concrete. About 13 ft. was cut off the 10-in. pipe and it was set back in the stack in an effort to set it over the 8-in. casing. The 10-in. pipe was driven down as far as possible and practically all of the flow confined to it.

An attempt was made to set a 6⅝-in. pipe inside the 8-in. casing. When this small pipe was in a particular position about 90 per cent of the flow was confined to it. A wall hook then was cut in the bottom of the 6⅝-in. in an attempt to get hold of the drill stem inside the 8-in. casing, but it was impossible to rotate it. A rotary arrangement was rigged up to rotate pipe as it was necessary to mill down over the drill stem.

Milling began October 4 and continued 24 hours a day until October 27, when it was possible to get down over the drill stem about 20 in. For fear of milling into the drill stem it was decided to cement an 8-in. pipe over the drill stem, filling this 20-in. joint with cement. A braden head was set on the 10-in. pipe and the 8-in. pipe packed inside it. A Halliburton cement truck pumped 35 sacks of cement slurry between the 8-in. and 10-in. pipes, getting returns through the 8-in.

The truck pumped in 30 more sacks of cement under 150 lb. pressure and flow was confined to the 8-in. pipe, without any evidence whatever of leakage of gas. This cement was allowed to set until November 3, when the braden head was removed and a christmas tree rigged up and placed on the top of the pipe. The christmas tree had, in addition to the main 7-in. pipe and valve, two side outlets for 2-in. pipe, and two heavy-duty 2-in. valves in each of the 2-in. outlets on the sides. There was no leakage whatever when the christmas tree was placed and the flow reduced to 7-in. The pressure gage showed 30 lb. with the 7-in. pipe open. The main valve then was closed and the entire flow confined to the two 2-in. outlets on the side of the christmas tree. This developed 250 lb. pressure and it was thought this would cause the well to load up with water and kill itself.

### Completely Shut In

On the morning of November 4 the flow was confined to one 2-in. outlet and the pressure rose to 600 lb. After flowing for two hours there was no decline whatever in the pressure, which indicated the well was not loading itself with water. At 3:25 p.m. the well was completely shut in and the pressure immediately rose to 1,000 lb. They then began pumping in cement and in 10 minutes the pressure was down to 500 lb., and in 20 minutes all pressure was gone and the well was taking cement by gravity flow, 200 sacks having been pumped in at this point. Three hundred more sacks were ordered immediately, and on receipt, 100 sacks were pumped into the well and allowed to set for 30 minutes. At 5 p.m. an attempt was made to resume pumping and the pump pressure immediately rose to 1,100 lb., indicating the cement previously pumped in had already begun to set. Further efforts to pump in cement were abandoned and there was no indication of any leakage whatever in any part of the crater. The following day the christmas tree was removed and the well sounded, and it was found the top of the cement was within 13 ft. of the top of the pipe. Sufficient cement was then poured in to completely fill the pipe and a bull plug was screwed in.

***Upper: A trolley line swung across the crater was used to get the stack in position. Middle: The stack in its proper position but not all of the flow is through it. Lower: Entire flow of the well is being directed through the stack which is guyed in place***

# SPARKS . . . FROM THE NEWS

**NO MAXIMUM:** Discounting recent statements that the maximum in motor-fuel efficiency for automotive engines has been reached, an Institute of Petroleum speaker predicted 50 per cent increase in gasoline mileage.

**QUERY:** Congressman Wolverton at least demonstrated that there is a limit to Secretary Ickes' omniscience; although it was asking rather much to insist upon a definite figure of our oil resources.

**SOMETHING NEW:** A wire service incorrectly quoted a government witness in the Cole hearing at Washington as saying "polarization, vatylization and analytic cracking give the oil industry greater flexibility."

**NO PRORATION:** Fortune magazine says the oil industry employs one-eighth of the country's research workers at $22,000,000 yearly. Their accomplishments do not have to be prorated.

**SUPPORT:** When financial troubles delayed work at a wildcat just east of their city, a group of St. Joseph, Mo., business men, anxious to find oil in their own back yard, bought half interest in the venture and drilling was resumed.

**CAME THE DAWN:** If reiteration will help, American business should soon be convinced that the present upswing is not the result of the European war, but of sounder general conditions and improved mental attitude.

**GOING UP:** Uncle Sam's new agreement with Venezuela will doubtless result in a substantial increase in Venezuelan production in 1940.

**NONEXISTENT:** The refining branch usually seems able to find some excuse for building up gasoline stocks that eventually damage the market. This time it was "war demand."

**RED:** Oklahoma governor's analysis of the Cole bill and its tendencies shows that "Red" knows "red" when he sees it.

**NEW CLASSIFICATION:** Petroleum is classed with orchids by the State Department in the new Venezuelan trade agreement, whose lower import duties on heavy oils are being widely criticized within the industry.

**STRAIT-JACKET:** More than 10,000 bills affecting highway users were introduced in 1939 in the 44 state legislatures that convened, of which 1,100 were enacted, charged a speaker at the A.P.I. Railroads, he said, are attempting to place highway hauling in a legalistic strait-jacket.

**COMMERCIAL PRODUCER:** Small boys quickly made Nebraska's first well a commercial producer by selling bottles of the crude to visitors who had come from all parts of the adjoining country. One lad reported a one-day net of $4.60.

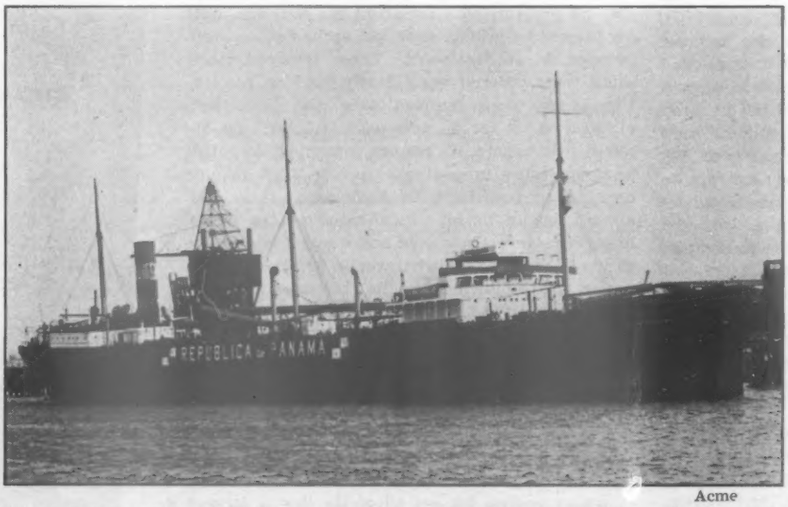
**SOPHOMORES:** Four members of the Cole subcommittee took part in the previous oil investigation. This is an improvement over the familiar practice of having novices who know nothing about the industry.

**CONFIDENCE:** Owners of the Nebraska discovery well, confident they have something really worth while in their 75,000-acre Nebraska-Kansas block, were reported to have refused an offer of $1,500,000 for their holdings.

**FOURTH:** As if reluctant to relinquish the spotlight to Nebraska, Mississippi appeared ready to grab back a share as its fourth producer loomed this week.

**IMAGINATION:** Testimony before the T.N.E.C. hearing failed to disclose skeletons which some members of the committee supposed were in the oil industry's closet.

## TANKER CHANGES COLORS . . .




Acme

*Former American tanker H. H. Rogers, manned by a Canadian crew and flying the flag of the Republic of Panama, in Boston Harbor, ready to sail.* *(See Page 101)*

*Three 500-bbl. tanks have been erected and pumping equipment is being installed at Pawnee Royalty Co.'s discovery well near Falls City, Neb., preparatory to a 60-day test necessary to obtain the $15,000 state bonus.*

# More Tests Follow Strike in Nebraska

**By DAL DALRYMPLE**

ST. JOSEPH, Mo., Nov. 13.—The discovery of oil near Falls City in Richardson County, southeastern Nebraska, provided the spark necessary to fan into flame the embers of a Forest City basin wildcat campaign that was beginning to suffer from too many dry holes.

With optimism ousting pessimism as soon as it became known definitely that Pawnee Royalty Co. had brought in a commercial producer at No. 1 Boice, C NE NE Section 18-1n-16e, about 2½ miles west of Falls City, basin operators speeded up their efforts to find oil in adjacent sectors of the four-state area.

In Iowa, Phillips Petroleum Co. announced location for its first test in the basin and was moving in equipment at No. 1 Creston, C SE NE Section 31-71-30w, about 10 miles south of the town of Creston in Union County. It was due to be spudded November 28, birthday anniversary of Frank Phillips, chairman of the company's board and former resident of Union County. Structure was determined by shooting and coring. Other wildcats already started in Iowa are Oscar Gruber's No. 1 fee, C SW SE Section 8-67-40w, Fremont County, shut down for casing at 1,065 ft., and F. E. Hunt and others' No. 1 McConnell, Section 11-78-30w, Guthrie County, a drilling well.

The bulk of drilling activity in the basin continues in the Missouri sector, which held the spotlight until the Falls City discovery stole the show. Twenty-odd tests are listed in Missouri, ranging from locations to drilling wells. Several dry holes have been completed, but some new gas areas have been opened.

### Missouri Tests Start

Missouri operations centering around St. Joseph were of particular interest due to proximity of the Falls City strike. Work has been resumed at Bob Miller and others' No. 1 Corrough, C SE SE Section 24-57-35w, Buchanan County, just east of St. Joseph. A group of business men of that city are interested financially in the well. To the south in Platte County, George A. Vincent and associates were moving in material at No. 1 Dillingham, C NE SW Section 16-53-34w, on a farmout block from Indian Territory Illuminating Oil Co. Davis Brothers have the contract for an Arbuckle-lime test.

Other northern and northwestern Missouri tests are at various stages of development in Holt, Andrew, DeKalb, Clinton, Clay, Ray, Daviess, Mercer, Adair, Schuyler, Randolph and Putnam counties.

Operations in northeastern Kansas were expected to increase as a result of the nearby Nebraska discovery. A part of Pawnee Royalty Co.'s block of 75,000 acres laps over from Richardson County, Nebraska, into Brown County, Kansas. Brown County appears in line for some activity in the near future, as it lies east of the Nemaha granite ridge, well up on the west side of the basin, and is looked upon favorably. Some of the major companies have acreage leased in Brown County and have explored it geophysically. Carter Oil Co. has started a slim-hole formation test in Section 24-4s-16e, near the town of Horton, using portable rotary equipment. The company recently completed a similar test in Atchison County, but results were not announced.

Other northeastern Kansas counties in line for exploration and drilling include Doniphan, Atchison, Jefferson, Leavenworth, Jackson and possibly others further down on the south and west rims of the basin.

### New Tests in Nebraska

The greater interest for the moment, however, is centered in Nebraska, where new tests are starting and testing is scheduled to begin soon at the Falls City well.

Pawnee Royalty Co.'s discovery well found Hunton lime at 2,276 ft., had pay at 2,279 ft. and was bottomed at 2,282 ft. It pumped 230 bbl. of accumulated and new oil in 24 hours and 130 bbl. net in the next 24 hours. It was deepened to 2,287 ft., more saturation was found and it was shut in without additional testing. Gravity of the oil was reported to be 30° to 32°.

The operators will seek the $15,000 bonus offered by Nebraska for the first oil well drilled in the state that produces as much as 50 bbl. daily for 60 days. More tanks have been ordered to augment the trio of 500-bbl. tanks now on the site and new pumping unit is being installed. When this is completed, the 60-day test will begin under supervision of a state official assigned to the task by Gov. R. L. Cochrane. Cost of drilling the well was approximately $30,000.

The Pawnee company will drill the second test on its Richardson County acreage at No. 1 Meyers, C NW NW Section 24-1n-15e, nearly 2 miles southwest of the discovery, according to B. G. Guinn, one of the owners. The cable rig used at No. 1 Boice was to be moved to the new location. Ferndale Drilling Co. of Odessa, Tex., contractor on the first well, also will drill the new test. The operators were expected to start their third well as a north offset to No. 1 Boice, but exact location has not been announced.

H. C. Stephens and Ed Uhri, of Humboldt, were preparing to start drilling at their No. 1 Stauffer, SW SW NE Section 22-1n-13e, in southwestern Richardson County, within a week.

### Nebraska Play to Expand

There were rumors of other wells to be drilled in the Nebraska part of the basin, but definite announcements had not been made. It was expected the Nebraska play would extend beyond Richardson County, northward along the Missouri River Valley as far as Cass County and almost to Omaha. A wildcat was started in Cass County several months ago at Golden Rod Oil Co.'s No. 1 Sporer, SE SE SE Section 8-11n-13e, but it has been shut down at 1,200 ft. for some time.

*Work and rumors of work are increasing in this Forest City basin area adjacent to St. Joseph, Mo., as a result of the first oil strike in Nebraska, near Falls City*

E. C. Jacobson, Maps, Tulsa

# KANSAS

THE KANSAS CORPORATION COMMISSION was told Friday, November 10, that use of wider spacing of oil wells in its proration regulations would enable operators to develop oil reserves at less expense.

"Wider spacing of wells aids the independent oil operators in that more reserves can be developed for the same money," Don R. Knowlton of Bartlesville, Okla., Phillips Petroleum Co. engineer, said in urging adoption of 40-acre spacing for wells drilled in Kansas.

Mr. Knowlton pointed out that any allowable formula "should give full consideration to acreage to prevent drainage between wells."

The present allowable formula based on the log-log curve could be adapted to 40-acre spacing by varying the acreage factor, he added.

Drilling of fewer wells on larger tracts also was proposed by Russell S. Knappen of Tulsa, assistant to the vice president, Gypsy Division, of Gulf Oil Corp., and an engineer. Mr. Knappen said 20-acre spacing would avoid unnecessary drilling and oil pools could be adequately drained in Kansas on 40-acre tracts.

He asserted "the difficulty with proration is that potentials are not taken frequently enough because a false assumption exists that a potential, once taken, is adequate for some time."

Discussing potential tests, Mr. Knappen said "there is no fairer method than the drawdown up to 3,000 bbl." but warned methods must be held within uniform limits "to prevent terrific waste."

Under present proration in Kansas, if there were no more drilling, potentials of wells could be expected to drop 7 per cent in the next year, Mr. Knappen testified. In contrast, he added, wells produced under open-flow conditions would deplete 60 to 70 per cent in the first year.

Even 40-acre spacing would drain oil reservoirs adequately in Kansas, the Tulsa engineer said, adding that eastern Kansas development prior to 1917 was on the basis of one well to each 2½ acres, and that the trend since the Eldorado boom has been toward 10-acre units.

# MICHIGAN

THE PROPOSAL TO ESTABLISH 20-ACRE diagonal spacing as a drilling-unit program in Michigan fields was turned down by the Oil Advisory Board at its regular monthly meeting last week. The action of the board met with the approval of J. P. Hoffmaster, supervisor of wells, who said it would not interfere with such spacing in the Wise field in Isabella County, where it has been in force since the field opened. The Wise field is not under state proration.

The board approved five-acre spacing as a base unit in the Dundee field in Monroe County due to the density of the Trenton-rock formation which requires close drilling in order to obtain the most drainage. Operators, however, may use 10-acre locations in that field if they so desire.

# ILLINOIS

ENACTMENT OF CONSERVATION LEGISLATION regulating the Illinois' oil industry would prevent an annual loss of $27,000,000 resulting from wasteful production methods, President John Pugh of the Independent Oil Producers Association of Illinois asserted in Springfield.

Mr. Pugh declared the need for a regulatory program is growing daily.

"Last spring," he said, "when this program for oil conservation was first started by our association, the daily loss from wasteful production methods exceeded $20,000 a day.

"With the increase in daily production we can add to that loss today $10,000 a day from one field alone—Salem-Lake Centralia—and another $45,000 a day from natural-gas gasoline wasted in the state. We can add more than $2,500,000 a month to Illinois' present oil revenue."

Mr. Pugh said the association favors a program to stabilize the Illinois industry, encourage more drilling, eliminate waste, insure fair treatment as between landowners, return to Illinois the price advantage which its geographical location gives it, and result in more ultimate recovery for each producing tract. Such a program, he declared, would increase earning power and would not harm any "efficient and legitimate branch of the oil business."

# CALIFORNIA

THE OVERWHELMING DEFEAT of the Atkinson oil-control bill which would have delegated the duties of running the California oil industry to the director of natural resources together with two other department heads was the most important event in California during the current week. Producers, marketers and refiners have already got their feet down on the ground again and are proceeding with normal business but many will be faced with the necessity of liquidating costs incurred in connection with the oil measure. Marketers are not any too sanguine over the outlook early next year as they fear the possible consequences resulting from cancellation of the Japanese trade treaty. Restriction of demand equal to the amount moved to Japanese markets annually will force operators to reduce crude-oil production an equal amount. In the meantime, all indications point to the probability that Japanese buyers will move every barrel of oil they can buy before the deadline and thus when under normal conditions the export market is light the shipments this year will be heaviest late in the year.

# STATE CAPITALS

*J. R. PEMBERTON, oil umpire in California, will continue his work, now that the Atkinson oil control bill has been defeated at the referendum, and the Central Committee of California Oil Producers will continue in its efforts to keep crude production close to actual demand with the assistance of the producers*

# TEXAS

A TEMPORARY INJUNCTION against enforcement of the current East Texas proration order was denied Humble Oil & Refining Co. last week by the three-judge court that heard the petition at San Antonio on October 10. The court, however, did not pass on the validity of the method of proration, so that it is expected that Humble will ask that the suit be set down for trial on its merits. Circuit Judge R. E. Foster of New Orleans and District Judge W. H. Atwell of Dallas signed the decree based on reasons advanced in an accompanying opinion. District Judge T. M. Kennerly of Houston concurred in the decision, but dissented from the reasoning. In its supplemental petition Humble had attacked the order on three counts: Contending that like the enjoined order the current order prorated the field substantially on a per-well basis; that the increased top allowable from 522,000 to 690,000 bbl. daily, would cause physical waste, and that the 20-bbl. minimum was not required by the law or the necessities of the case.

The court pointed out in its opinion that under the injunction granted Humble against the old order, Humble was permitted to produce 144 per cent of the amount granted it under the proration order when the field allowable was 522,000 bbl. The new order, said the court, gives the company 148 per cent of 522,000 or 11.15 per cent of the increased field total of 690,000 bbl. (about 76,960 bbl. under the new order as compared with 75,880 bbl. daily under the order with a top allowable of 522,000 bbl.). In its conclusions of law the court held:

". . . The Railroad Commission has authority to prorate the amount each well shall be allowed to produce but its order must be reasonable and fair. The findings of fact by the commission are not conclusive and any party in interest has the right to appeal to the courts for relief. However, orders of the commission, promulgated after a hearing, are entitled to prima facie weight. Usually, courts do not permanently set them aside unless convinced they are invalid, after a hearing on the merits. In this case the interlocutory injunction was issued to prevent irreparable loss until a hearing could be had on the merits and final decree entered. It is apparent from the above facts that the order of September 29 does not deprive the plaintiff of the benefit of the interlocutory injunction heretofore issued. There is no occasion to enter another interlocutory decree at this time."

THE RAILROAD COMMISSION, after first announcing that Rowan & Nichols' five wells in the East Texas field (which are producing under a federal court injunction granted the company last summer) would be placed under the current proration order, later decided against such action and will continue to allow the wells to operate under the injunction until the case has been heard by the U. S. Supreme Court. Commissioner Jerry Sadler stated the commission had decided such action was best in order to insure the commission's right to appeal to the Supreme Court. This was in order not to render the question moot. The injunction under which Rowan & Nichols has been operating gives it an allowable of about 90 bbl. in excess of the amount the lease would have if placed under the commission's order.

ANOTHER COURT ATTACK on the commission's East Texas method of prorating production is expected to be filed in the near future. This attack will be made by operators on the west side of the field, who have formed the "Committee of West Side Operators," in an attempt to obtain an adjustment in the allowable of their wells to offset the drainage to which they are being subjected by the natural water drive to the east. Chairman of the newly formed body is J. H. Edwards of Maco Oil Co., Henderson, while Jack Bialock, Houston, has been engaged as counsel with F. N. Spellers as engineer.

SUIT CHARGING 49 EAST TEXAS OPERATORS with violations of the laws against stream pollution was filed in Dallas last week. The named defendants, which include several major companies and large East Texas operators, operate wells in the southwest edge of the field which produce large quantities of salt water.

the OIL AND GAS JOURNAL

PRODUCING REFINING NATURAL GASOLINE PIPE LINE

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# Just the Opposite . . .

Government officials, seeking excuse for extending federal control over the oil industry, currently reflected at the Cole committee hearings, are pointing to the defeat of the California conservation bill and the delay of action in Illinois, as exhibits for their contention.

A little study of the conditions in these two states should convince Washington that back of these situations is the popular feeling against any further extension of governmental control over business.

One of the controlling factors in California was the voters' fear that approval of state conservation might mean higher prices for petroleum products.

Having in mind the developments of the past several years there is a stronger and stronger feeling among the rank and file of Americans that governmental interference in business means higher prices to them. The plowing under of crops, the slaughter of little pigs, and numerous other expedients of the federal Government's experiments in the economics of scarcity are blamed for higher living costs.

Due to the voluntary accomplishments of operators in California, consumers in that area, as in all other sections of the country, are purchasing their petroleum products, accompanied by super-service, on a basis not approached by anything else that they buy.

Confronted constantly by the results of the bootstrap economics of Government, it is not to be wondered at that many voters, having no clear understanding of the issue involved in oil legislation, should play safe and be satisfied with things as they are.

California operators acting voluntarily have been able to iron out most of the difficulties with which the industry in that state has been confronted, and there is every reason to believe they will continue to do so in the future. Approval of the conservation act would have been helpful to California operators and it is certain that a similar act will eventually be approved. Meanwhile the consumers supplied by the west coast certainly have no cause for complaint.

As to Illinois, the postponement of state action there simply reflects the fact that the people of that state are still not familiar with the fundamental conditions in the industry.

It takes time to bring about the right attitude on the part of the voters and there is no reason to believe this cannot be accomplished in Illinois as in other states.

State officials and organizations representing groups of voters in that state have made it clear they are unalterably opposed to any form of federal control.

The main point here is that the application of conservation principles, regardless of the action of governmental agencies, to a large extent depends upon the good faith of the industry itself.

There has not been an important conservation principle applied which was not developed within the industry and its application made possible through the cooperation of the large majority of the industry. Operators, as a group, have realized the necessity to conserve our petroleum resources, both as a protection of the nation and themselves, and have worked out the plans through which this has been accomplished.

The minor exceptions should not be permitted to obscure the rule of good conduct to which the industry has subscribed, or criticism of state regulation be made an excuse for extension of federal control which is not wanted, either by the industry itself, or by its consumers.

The greatest contribution that official Washington can make to the oil business and all business is to conduct its fiscal affairs so that the citizenry once more will have confidence in governmental judgment and integrity.

# Wildcats, Oil Shows Accelerate Interest in Mississippi

MISSISSIPPI'S oil play continued strong this week, with leasing heavy in many sections and new wildcats staked. Activity is centering in the Vicksburg-Jackson area ,interest being shared by the Northwest Alabama basin, extending into northeastern Mississippi. Oil seepage in Wilkinson County and oil and gas shows in Itawamba and Kemper County wildcats were reported. The Tinsley field, Yazoo County, is expected to be extended on the west and east early next week.

The Tinsley field is producing about 325 bbl. daily, with about 20,000 bbl. of cumulative production. Of the five drilling tests, two are nearing the pay. Jones & O'Brien Brothers' No. 2 Stevens, C SE NE Section 13-10-3, east offset to their No. 1, is coring below 4,480 ft. in the Selma horizon; first oil saturation logged at 4,475 ft. This offsets the best well in the field and is an east-edge test.

On the west edge Union Producing Co.'s No. 1 Friley, Section 14-10-3, ½ mile west of the discovery, is coring for the Selma pay. On the north, Union's No. 1 Stevens is coring below 5,630 ft. after another show of oil. A 2-mile-east outpost, Yazoo Refinery, Inc.'s No. 1 Frank Brooks, is rigged up and expected to spud shortly.

The north outpost, Edgar Johnson and others' No. 1 Brumfield, SE cor. Section 2-10-3, has a derrick up. This test is northwest of Tinsley townsite and over 1 mile north of Union's Stevens test. Jones & O'Brien have staked location for No. 3 Stevens, north offset to Union's Stevens; Harry Hanbury and others have made location for No. 1 Brooks in Section 17-10-2 near the Yazoo Refinery location; and Union Producing Co. is rigging No. 2 Woodruff in Section 13-10-3.

Prospects for a third horizon faded as Union Producing Co. tested salt water in a sand cored at 5,493-5,508 ft. in No. 1 Stevens, deep test on the north edge of production. The colored oil sand cored was given a drill-stem test at 5,486-5,508 ft. using ⅝-in. choke top and bottom. In 13 minutes the recovery was 3,800 ft. of salt water with a working pressure of 10 lb. The test is coring in the Tuscaloosa formation.

Recently an oil sand at 4,865-77 ft. in the Eutaw formation tested 2,900 ft. of 36 gravity and one joint of gas-cut mud on a drill-stem test at 4,860-77 ft. This lies below the Selma section which is producing the three present wells.

### Wildcat Locations

Another Yazoo County wildcat was staked, Conroe-Wilcox's No. 1 Stubblefield, Section 25-12-1w, 20 miles northeast of the Tinsley field, 8 miles east of Yazoo City and 4 miles north of Benton. Material is being moved in.

Hinds County's deepest wildcat, Mississippi Basin Oil & Gas Co.'s No. 1 Gaddis Farms, Section 17-7n-2w, between Bolton and Edwards, was reported coring below 5,500 ft., having topped the Selma chalk at 4,856 ft. Byrd-Frost and others' No. 1 Gaddis Farms, Section 12-6n-3w, between Jackson and Vicksburg, was spudded.

### Northwest Alabama Basin

Northeast Mississippi's only active test, G. C. Grasty and others' No. 1 Kentucky Lumber Co., Section 7-10s-10e, near the Alabama line, reported a showing of oil or gas at 560-70 ft. in hard lime. It is drilling below 850 ft. A second wildcat has been staked, and Willmut Oil & Gas Co.'s No. 1 Roberts, Section 18-13s-17w, in the Amory gas field of Monroe County is rigging up.

### Seepage Investigated

An old oil seep on the Mississippi River in Wilkinson County was again apparent, due to the low stage of the river. H. M. Morse, supervisor of the state Oil and Gas Board, investigated the seep in Section 3-1n-5w and reported it very evident for about 300 ft. along the river bank. Acreage in the vicinity is blocked by Sun Oil Co. Considerable gas seepage is also reported about 1 mile east of Fort Adams on the Buffalo River.

In Kemper County, East Central Mississippi, M. R. Crabb and others' No. 1 W. T. Caldwell, NW SE Section 25-9n-15w, is reported to have tried to blow out at 2,100 ft. The test is near Daleville, north of Meridian.

# DEATHS

**WILLIAM R. MITCHELL,** 64, of Dallas, Tex., builder of pipe lines, died November 12. A native of Scotland, he went to Texas 27 years ago. He had been in the pipe-line construction business in Pennsylvania, New York, Texas, and Oklahoma since 1907.

**O. R. JEFFERS,** of Midland, Tex., independent oil operator, was killed accidentally while hunting near Carlsbad, N. M. Head of Jeffers Oil Co., he went to Wichita Falls in the early days and was one of the first drillers to find production in the Olney field.

**JAMES W. MATTHEWS,** 67, oil producer and refiner, of Bradford, Pa., died on Sunday, November 13. Deceased was a member of the oil firm of Johnston & Matthews. He pioneered in the business of casing-head gasoline extraction and assisted in the organization of refineries in the Bradford and Allegany fields.

**JOHN C. MILLER,** 73, special sales representative of Mid-Continent Petroleum Corp., Tulsa, died November 13. Mr. Miller, who became a tank-wagon salesman for Atlantic Refining Co. in Philadelphia, Pa., in 1888, was said to have had more years of oil sales experience than any other man in the Southwest. In his first job he rode on a wooden-wheeled horse-drawn wagon, delivering kerosene and lubricating oils in buckets direct to groceries. He went to Oklahoma in 1917 as sales manager in Muskogee for Oklahoma Producing & Refining Co., later acquired by Pure Oil Co. He joined Mid-Continent in 1925.

### Special Federal Jury Indicts California Companies

LOS ANGELES, Calif., Nov. 14—A special federal grand jury today indicted more than two score oil companies on charges of conspiring to control the price of retail gasoline in violation of the antitrust act.

The indictments were returned after several months' investigation in which prosecutors sought to determine the reason for the "remarkable stability" in gasoline prices in California.

The defendants are Standard Oil Co. of California, Texas Co., General Petroleum Corp., Richfield Oil Corp., Shell Oil Co., Inc., Tide Water Associated Oil Co., Union Oil Co., Gilmore, Rio Grande, Seaside, Signal, Sunset, Aromaline, Inc., R. R. Bush, California Oil & Refining, Century, Caminol, Eagle, East-West, El Camino, El Tejon, Envoy Estado, Exeter, Fletcher, Hancock, Harbor, Kern, MacMillan, Mercury, Mohawk, Norwalk, Olympic, Pan-Pacific, Petrol, Rothschild, Socal, Triangle and White Star companies, Independent Refiners Association of California, Inc., and Fair Practices Association.

The Government charged the defendants brought about the organization of two associations, the Fair Practices Association, composed of major and all but one of the secondary concerns, and the Independent Refiners Association of California, Inc., which consisted of one secondary company and a group of independents.

The indictment set forth as evidence of conspiracy a program of purchases by majors of gasoline produced by independents; arbitrary prices designed to eliminate competition, and that with the major companies making such purchases the independents agreed to maintain prices for the rest of their gasoline at or about the same level.

The indictment further charges that independent refiners were allotted fixed quotas which had the effect of limiting the amount of gasoline each could produce.

## THE MARKETS*

CRUDE OIL: Production in Texas increased 261,949 bbl. per day in the past week, which, together with increases in California and Oklahoma, brought the increase in the United States to 291,093 bbl. per day. A 5-cent increase in Bloomingdale and Columbia, Michigan, crudes and a 3-cent increase in West Branch, Michigan, crude were posted, and the Standard Oil Co. of California posted prices in the Coles Levee and Richfield Western fields in Kern County, California, for the first time, ranging from $1 for 27 gravity up to $1.61 for 46 gravity and above.

REFINERY: Softness prevails generally in gasoline, with growing concern manifested over mounting stocks and failure of oversea demand to make predicted reductions in accumulations at the Gulf. Lubricating oils holding; extremely tight in Gulf Coast area. Wax keeping its gains. Heating oils stronger as delayed wintry weather arrives.

TANK WAGON AND POSTED DEALER: Changes confined to local adjustments in scattered areas.

FINANCIAL: Oil issues declined to the lowest point touched since mid-September, but their average performance has been slightly better than that of the general list. Average of 30 representative stocks for week ending November 10: High, 28.58; low, 27.37; close, 27.57. Week ending November 4: High, 29.05; low, 27.07; close, 28.60.

*Detailed information in market section.

# Village of Lagunillas Destroyed

CARACAS, Venezuela, Nov. 14.—Explosion of a gasoline lamp in a shore saloon started a fire which virtually destroyed the village of Lagunillas, built on stilts at the edge of Lake Maracaibo, Monday night, causing deaths estimated at more than 500 and damage exceeding $1,000,000. The population of Lagunillas was about 2,500. A bridge connecting the stilted village with the mainland was burned soon after the fire started, cutting off escape. Floating patches of heavy oil on the surface of the lake caught fire and increased the difficulty of reaching safety.

Many of the occupants of the lake houses were employed by oil companies with operations in that district. Others made their living by fishing. The lake homes—crude and roughly built structures—were preferred to homes on the land because of freedom from mosquitoes, cooling breezes, and the ease with which garbage and other waste material could be disposed of.

The Gulf, Lago, and Shell companies have oil operations at this point, many of them out in the lake. All these companies have camps on made ground in the swampy area near Lagunillas. The parcels (corresponding to leases in the United States) are usually ½ mile wide and 1½ miles long, paralleling the shore of the lake, which is 60 miles wide and 200 miles long.

The floating patches of 17-gravity crude, after being exposed to the weather, becomes thick and slow-burning. Some victims lost their lives through leaping into the water. Several score were reported to have crowded a launch, which overturned while trying to make the shore. Lagunillas is a shipping point for oil produced in that region.

## *Amerada Develops Special Rotary Drill Stem for*

# *Simultaneous Electrical Logging and Drilling*

**By PAUL REED**

**Five wells have been drilled with an electrical record of formations being made while the drill stem was making hole. The first four wells were in proven areas while the last one drilled was a wildcat. All wells were resurveyed after completion by the conventional method. The company will use this method on a sixth well started in Texas this month.**

RECOGNIZING the striking advantages to be gained through instantly and continuously recording the formations penetrated in the course of drilling a rotary well, Amerada Petroleum Corp., in a research program which has been carried on for nearly 5 years, has developed electric-logging equipment to accomplish this result.

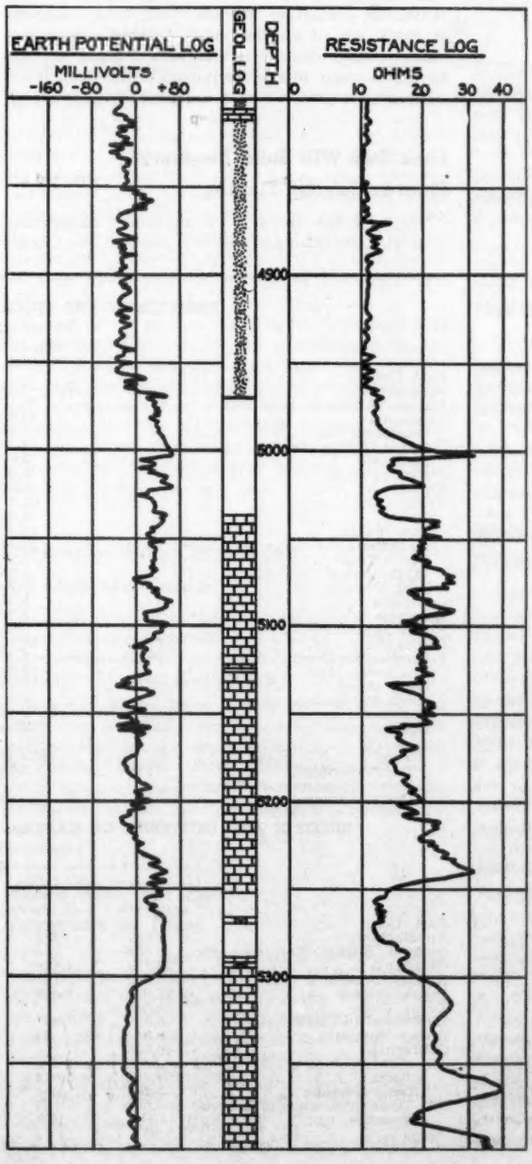
This work has been conducted under the direction of C. V. Millikan, chief engineer for the company. It has been done under the direct supervision of David G. Hawthorn, development engineer, with the assistance of John E. Owen, of the laboratory of the Geophysical Research Corp. where all recording and control apparatus has been designed and assembled. Horance Payne and J. L. Coulson, junior engineers with the company, have also played important parts in the construction and operation of the equipment.

In 1938 and 1939 five wells were drilled with this equipment. Last year one well was drilled in the Langston pool, Oklahoma, to 4,900 ft. and two wells were drilled in the Fairbanks pool, Texas, where the special drill stem was used to an approximate depth of 5,000 ft., since this was the total length of the special pipe available at this time. These two Fairbanks wells were ultimately completed at a depth of 6,800 ft. with conventional equipment. This year another Fairbanks well was drilled by the same method and also a well was drilled at Haskell, Tex. Amerada Petroleum Corp. will now use this method for recording formations in the drilling of its No. 10 Berk, in the E. G. Rector Survey of Anderson County, in the Cayuga field, Texas. The well was started about November 15.

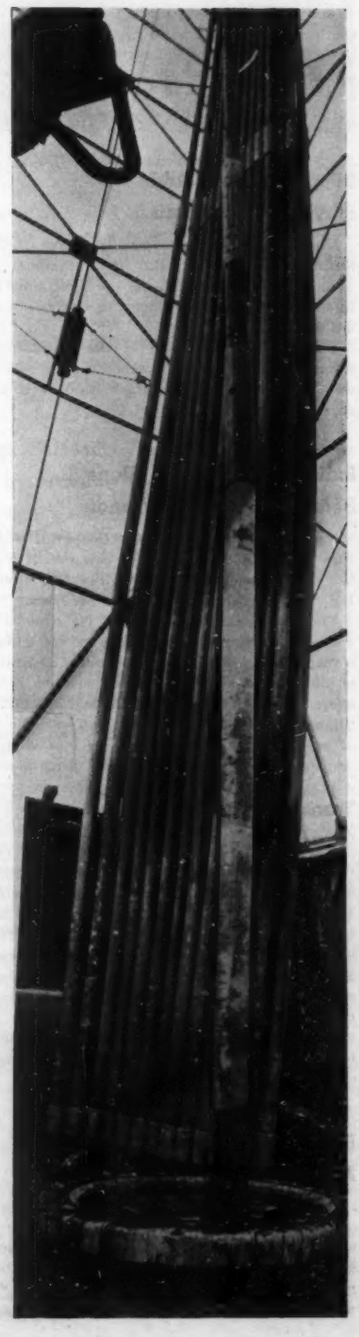
The first work on a method for simultaneously logging and drilling was done a number of years ago by Dr. J. C. Karcher, president of Geophysical Service, Inc. At that time interest shown in electrical logging was growing rapidly, and, appreciating the enhanced value of an electric log if it could record conditions of the formation, the instant it was first cut by the bit, he developed a small string of special core-drill pipe and secured basic patents. Amerada later came into the picture to develop the process to standard rotary drilling. In 1935 work was started on this project and for 2½ years was carried on in the East, working out constructional details at manufacturing centers. The last half of 1937 was spent assembling all equipment at the company's shops at Seminole, Okla.

The equipment consists of specially constructed kelly, drill pipe, tool joints, and drill collars. Recording and control equipment is centered to a large extent in a house trailer. Only the front part of the trailer is required for this purpose, as seen in the illustration, the remainder being fitted in the usual manner as living accommodations for

*(Continued on Page 96)*




*Below: Special drill pipe shown standing in derrick at Kleiner well. Hanging over the hole is the bakelite insulated drill collar. Left, below: Section of electrical log taken on Kleiner well*



# Refinery Expansion

### Ethyl Corp. Will Spend $4,000,000 On Expansion Program

A $4,000,000 plant expansion program is announced by the Ethyl Gasoline Corp. Manufacturing facilities at Baton Rouge, La., will be enlarged to meet the increasing needs of petroleum refiners for higher anti-knock gasoline, according to E. W. Webb, president of the corporation. Construction work will begin immediately.

A plant for manufacturing tetraethyl lead, processing plants for raw materials including an additional ethyl chloride plant, added capacity for the electrolysis of salt brines to manufacture metallic sodium and chlorine gas and other improvements are planned. This project will require the employment of between 800 and 1,000 men for construction, covering a period of about 1 year, and will be contracted for and done under the supervision of E. I. du Pont de Nemours & Co., which company has contracted with Ethyl to operate a substantial portion of the plants at Baton Rouge owing to the former's long experience and technique developed in similar manufacturing operations at Deepwater, N. J., and Niagara Falls, N. Y.

### Illinois Refinery Adds Ethyl Blending Plant

Maynard Taxman, secretary-treasurer of the Advance Refining Co. of Centralia, Ill., announces installation of an ethyl blending plant, the first unit of its kind to be installed at a refinery in the new Central Coal basin.

The unit will be used in the manufacture of the company's regular leaded gasoline. The new equipment was installed under the supervision of B. G. Crane, a representative of the Ethyl Corp.

### Indiana Cooperative Plans Refinery for Mount Vernon

The Indiana Farm Bureau Cooperative Association, Inc., has completed plans for erection of a refinery in the near future on a site northwest of Mount Vernon, Ind. It will cost approximately $250,000.

The association has bought river-front land from John H. Moeller, to permit use of the Ohio River for transportation of oil. Ralph Booker, assistant manager of the association's oil division, will be refinery manager. The plant's capacity will be 2,500 bbl. daily. Distillate, tractor fuel, residual fuel oil and all grades of gasoline and kerosene will be manufactured.

### Transport Oil Refinery is Completed at Dupo, Ill.

Latest of the small southern Illinois refineries to be completed is Transport Oil & Refining Co.'s 1,500-bbl.-a-day skimming plant south of Dupo, St. Clair County, in the far southwest part of the state. The plant is reported starting operations. It is adjacent to the Plank Road oil pool, in which there has been considerable development recently, and reportedly will operate partly on crude from there and partly from the East. This is the twenty-fourth small refinery to have been placed in operation in the last 2 years on southern Illinois crude.

### Refinery Under Construction At Kalamazoo, Mich.

MOUNT PLEASANT, Mich.—Peerless Purchasing Co. of Detroit has a 1,000-bbl. capacity straightrun refinery under construction at Kalamazoo, Mich., scheduled to go on stream late in November. It will be the first refinery at Kalamazoo and will buy crude from southwestern Michigan fields. It will be the fourth new plant for Michigan this year. Pantagon Refining Co., with a 3,000-bbl. straightrun plant at Starks, near Plymouth, Mich., is installing a new still and fractioning tower which will step up the plant's capacity to 4,000 bbl. daily.

### Quaker State Starts Furfural Solvent Unit Construction

OIL CITY, Pa.—The Quaker State Oil Refining Corp. is starting work on the erection of a furfural solvent extraction unit at each of its Farmer's Valley, Pa., and St. Mary's, W. Va., refineries. A new boiler house is also under construction at its Emlenton, Pa., refinery. The company expects to install a furfural unit at the Emlenton plant later.

This work follows the completion of a gasoline improvement program which entailed the installation of midget catalytic polymerization units at Farmer's Valley, St. Mary's, and Emlenton. The former was put on stream in April and the others only recently. The corporation's fourth refinery at Oil City is a partner in the cooperative polymerization plant there.

### Texas Carbon-Black Tax

The Texas state tax on carbon black must be paid on the actual market value of each type of black produced, Atty. Gen. Gerald C. Mann has advised Comptroller George H. Sheppard. Heretofore the tax has been collected on a basis of the average value of the output.

# Natural Gasoline

### Carter's Pressure Plant Is Nearing Completion

CENTRALIA, Ill.—Carter Oil Co.'s pressure maintenance gas plant in Louden Township, Fayette County, is nearing completion. The plant will have a capacity of 30,000 gal. of gasoline daily. Another maintenance plant, recently doubled in size, also is being operated by the company in another section of the field. It has a capacity of 5,000,000 cu. ft. of gas daily.

### Lone Star Will Build Recovery Plant in Cayuga Field

The Lone Star Gasoline Co. announced construction of a $190,000 distillate recovery plant in the Cayuga field, East Texas. The recycling plant will extract gasoline from natural gas. The gas later is returned to the reservoir for transfer into the company's gas lines.

Chairman T. B. Gregory said Lone Star and three other large companies pooled their acreage to build the plant and drill three wells, which are practically completed. The total cost will be nearly $300,000. He said the wells will produce 50,000,000 to 60,000,000 cu. ft. of gas daily and each million cubic feet will yield 35 bbl. of distillate.

### Natural Gasoline Production Increased in United States

The production of natural gasoline increased in September 1939, according to a report prepared by the

**PRODUCTION AND STOCKS OF NATURAL GASOLINE**

(Thousands of gallons)

| | September 1939 | August 1939 | Jan.-Sept. 1939 | Jan.-Sept. 1938 | At refineries |
|---|---|---|---|---|---|
| East Coast | ..... | ..... | ..... | ..... | 7,602 |
| Appalachian | 4,492 | 4,019 | 48,168 | 48,554 | 672 |
| Illinois, Michigan, Kentucky | 1,195 | 1,103 | 10,290 | 9,247 | 2,352 |
| Oklahoma | 34,531 | 25,281 | 322,758 | 351,642 | 3,654 |
| Oklahoma City | 7,856 | 5,775 | 76,715 | 108,323 | ..... |
| Osage County | 4,349 | 2,974 | 37,529 | 40,967 | ..... |
| Seminole | 9,675 | 7,032 | 90,118 | 92,133 | ..... |
| Rest of state | 9,022 | 9,500 | 118,396 | 110,219 | ..... |
| Kansas | 4,552 | 3,890 | 41,899 | 40,231 | 84 |
| Texas | 62,770 | 43,751 | 505,757 | 508,270 | 5,922 |
| Gulf | 8,985 | 5,416 | 56,770 | 47,137 | 5,082 |
| East Texas | 16,666 | 9,422 | 138,790 | 143,027 | ..... |
| Panhandle | 20,478 | 16,870 | 172,270 | 183,042 | ..... |
| North Texas | 2,271 | 2,013 | 19,776 | 19,877 | ..... |
| West Central | 5,348 | 4,655 | 48,201 | 54,225 | ..... |
| Rest of state | 9,022 | 5,375 | 69,950 | 60,962 | ..... |
| Louisiana | 8,275 | 7,133 | 65,359 | 70,793 | 84 |
| Arkansas | 2,122 | 1,967 | 19,106 | 18,602 | 504 |
| Rocky Mountain | 7,414 | 5,363 | 65,013 | 59,708 | 5,166 |
| California | 48,193 | 50,293 | 457,044 | 494,203 | 81,270 |
| Huntington Beach | 2,690 | 2,828 | 25,927 | 32,131 | ..... |
| Kettleman Hills | 10,906 | 12,581 | 121,737 | 138,560 | ..... |
| Long Beach | 7,390 | 7,315 | 64,902 | 69,155 | ..... |
| Santa Fe Springs | 4,662 | 4,873 | 43,800 | 47,823 | ..... |
| Ventura Avenue | 4,992 | 5,141 | 45,294 | 44,442 | ..... |
| Rest of state | 17,553 | 17,555 | 155,384 | 162,092 | ..... |
| Total | 173,544 | 142,800 | 1,535,394 | 1,601,250 | 107,310 |
| Daily average | 5,785 | 4,606 | 5,624 | 5,885 | ..... |
| Total (thousands of barrels) | 4,132 | 3,400 | 36,557 | 38,125 | 2,555 |
| Daily average | 138 | 110 | 134 | 140 | ..... |

**RECEIPTS AND DELIVERIES OF NATURAL GASOLINE, BY DISTRICTS, SEPTEMBER 1939**

(Thousands of gallons)

| | Deliveries | | | | | Receipts | |
|---|---|---|---|---|---|---|---|
| | To refineries | To refinery-owned bulk plants | To jobbers and retailers | Exports | At refineries | At refinery-owned bulk plants | By jobbers and retailers |
| East Coast | ..... | ..... | ..... | ..... | 162 | 16 | 307 |
| Appalachian | 2,657 | 323 | 2,813 | 478 | 2,780 | 323 | 1,331 |
| Indiana, Illinois, Kentucky, etc. | 838 | ..... | 543 | 8 | 17,977 | 4,751 | 2,151 |
| Oklahoma | 32,774 | 4,496 | 1,224 | 47 | 18,991 | 36 | 1,128 |
| Kansas, Missouri, etc. | 3,103 | 161 | 225 | ..... | 11,393 | 455 | 152 |
| Texas Inland | 37,830 | 1,669 | 1,594 | 386 } | 46,431 | 998 | 2,913 |
| Texas Gulf | 18,649 | ..... | 1,409 | 16,091 } | | | |
| Louisiana and Arkansas | 5,934 | 341 | 1,560 | ..... | 4,709 | 341 | 1,370 |
| Rocky Mountain | 6,844 | 24 | 52 | ..... | 6,186 | 94 | 68 |
| California | 46,225 | ..... | 240 | 2,226 | 46,225 | ..... | 240 |
| Total | 154,854 | 7,014 | 9,660 | 19,236 | 154,854 | 7,014 | 9,660 |
| Daily average | 5,162 | 234 | 322 | 641 | 5,162 | 234 | 322 |
| Total (thousands of barrels) | 3,687 | 167 | 230 | 458 | 3,687 | 167 | 230 |
| Average v.p. | 21.6 | 15.9 | 14.7 | 18.4 | 21.6 | 15.9 | 14.7 |

Bureau of Mines. The daily average in September was 5,785,000 gal., compared with 4,606,000 gal. in August 1939. The large gain raised production higher than it was prior to the 15-day shutdown. The outstanding increases were in East Texas, Panhandle, and Texas Gulf districts.

Stocks continued to decrease and totaled 247,442,000 gal. on September 30, 1939. This was 30,786,000 gal. less than reported for August 1939 and 95,256,000 gal. less than on hand September 30, 1938.

Shipments to jobbers and retailers increased from 8,694,000 gal. in August to 9,660,000 gal. in September and exports from 15,346,000 to 19,236,000 gal.

The average vapor pressure of all shipments increased, and the weighted average for all movements in September was 20.7 lb. compared with 19.2 lb. in August and 19.6 in September 1938. Since about March of this year the average vapor pressure has consistently run ahead of the corresponding pressures of 1938.

# Natural Gas

### Texas Natural Gasoline And Gas Increase

AUSTIN, Tex.—Statisticians of the Railroad Commission reported that dry gas production in September of 2,363,515,000 cu. ft. daily was up 15.3 per cent over August and 5.3 per cent over July.

An increase in casing-head gas production of 227,227,000 cu. ft. daily to 1,220,189,000 cu. ft., the engineers reported, resulted in a corresponding increase of production of gasoline which rose 2,209,264 gal., an average of 0.914 gal., was recovered per 1,000 cu. ft. processed, with gasoline plants taking 2,415,835,000 cu. ft. of gas daily.

Carbon black production of 1,301,328 lb. daily was 14.4 per cent over August and 5.2 per cent over July, and the greatest since the first of the year. The plants recovered 1.47 lb. per 1,000 cu. ft. of gas.

### Oklahoma Supreme Court Ruling on Responsibility

The Oklahoma Supreme Court ruled that a gas company operating as a public utility is responsible for keeping its lines in condition to furnish its customers with an adequate supply of gas.

Under the ruling, the Oklahoma Natural Gas Co. of Tulsa must pay $30 damages to Addie Pack and $70 damages to her granddaughter, Phyllis Madison, who suffered serious colds in January, 1937, when gas service failed at their Tulsa residence. It was brought out that gas lines had filled with moisture which had frozen and blocked the pipes.

### Plant Valued at $100,000; Auctioned for $30

CLARENDON, Tex.—The Clarendon property of the City Gas Co., a natural-gas distribution plant valued at $100,000, was sold at public auction for $30 to satisfy a $10.48 judgment and cost returned in justice court August 2. Bert Smith, Donley County gin man, was the successful bidder in the sale conducted on the courthouse steps by a precinct constable.

The sale was called to satisfy a judgment by Justice W. A. Davis in a suit filed by County Judge R. Y. King.

### Madison Case Appeal Supreme Court Hears

WASHINGTON, D. C.—The Supreme Court took under consideration the question whether federal District Judge Patrick T. Stone acted correctly in dismissing indictments against 11 defendants in the Madison, Wis., oil case.

Thurman Arnold, assistant attorney general, argued the procedure "puts a premium on inattention" by the judge and "makes the jury verdict purely advisory."

Weymouth Kirkland, Chicago attorney, replied that "instead of causing the judge to lose his sense of responsibility, it has the opposite effect."

# Pipe-Line Activity

*Work in progress on one section of the recently completed Sohio Corp.'s 10-in. line from Salem field to Stoy, Ill.*

### Illinois Commission Asks Reduction in Rates

WASHINGTON, D. C.—Attorneys for the Illinois Commerce Commission and the Federal Power Commission filed a motion with the F.P.C. asking that the commission order an immediate reduction in rates charged by Natural Gas Pipe Line Co. of America and its subsidiary, Texoma Natural Gas Co., without waiting for termination of the hearing in progress on the case. This marks a new step in natural-gas rate cases.

In making the motion, the attorneys contended that the evidence submitted by the companies as to the going value and rate of return establishes that the rates now charged are "unjust and unreasonable." The motion contended that a fair rate of return to the companies would be not more than 6 to 6½ per cent.

Federal Power Commission officials stated that this represents the first attempt to define a fair rate of return in a natural-gas rate case.

### Comanche Wins Claim It Is Not Common Carrier

AUSTIN, Tex.—The Railroad Commission sustained the contention of Comanche Pipe Line Corp. that it was not a common carrier and therefore the commission did not have jurisdiction to establish a rate.

Operators in the Pecos County area served by the system had petitioned the commission to establish a rate, and the company contended that it was not within the common carrier statute and was sustained in an order signed by Chairman Lon A. Smith and Commissioner Jerry Sadler. Commissioner E. O. Thompson did not sign it.

### Valley Pipe Line Plans Extensions in Texas

FORT WORTH, Tex.—Four fields in three South Texas counties will be served by extensions of the Valley Pipe Line Co.'s crude-oil line, Frank T. Murchison, San Antonio, president of the company, announced. Work on the line is expected to start this month.

Surveys are under way to build a 25-mile extension to the Sun's Las Cuevitas field in northern Starr County, which is producing about 15,000 bbl. per month; an extension from El Tanque, the new Rincon field in Starr County, and to Standard's Alta Mesa field in Brooks County. These two extensions will be about 50 miles in length.

Several pump stations will be built along the line, which will vary from 4 to 4½ in. in diameter. Field headquarters for the company are in McAllen under the management of H. H. Hensley. The oil is piped from the main booster station to McAllen to Port Isabel, where it is loaded on tankers.

### Line From Colorado Field Planned by Humble

HOUSTON, Tex.—Humble Oil & Refining Co. will build an 8-mile pipe line from the Colorado field in southern Jim Hogg County to the line at the Charco Redondo field, which is connected with port facilities at Ingleside. Humble has 14 producing wells in the Colorado field. It is estimated the extension will cost more than $40,000.

### West Michigan Consumers Project is Approved

SAGINAW, Mich.—The Michigan Public Service Commission has approved the project of the West Michigan Consumers Co. to lay a gas pipe line from the Walker and Wyoming fields in Kent County to the terminal of the company's present line in the Michigan field. The company will buy and transport casing-head gas from the Kent County field, much of which is now said to be going to waste. The company's plans include a supply of gas for the city of Grand Haven.

### Petroleum Equipment Suppliers Association Elects

CHICAGO, Nov. 15.—The Petroleum Equipment Suppliers Association elected E. S. Dulin, president, Byron Jackson Co., Los Angeles, as president for 1940, succeeding John L. Shakely, president, Frick-Reid Supply Corp., Tulsa. E. W. Gildart, Norvell-Wilder Supply Co., Beaumont, Tex., is the new vice president, and Wharton Weems, Houston, was reelected executive counsel.

Directors named included J. L. Shakely, W. M. Bovaird, Guy A. Thompson, Frank Hinderliter, J. R. Brooks, all of Tulsa; Earl W. Miller, Oklahoma City; A. A. Moody and John Larkin, St. Louis, and D. R. Brown, Coffeyville.

# Venezuelan Treaty Arouses Outburst of Criticism

WASHINGTON, D. C., Nov. 13.—The reciprocal trade agreement with Venezuela, the important part of which is a reduction in the import tax on crude petroleum and fuel oil, has aroused opposition to the administration's foreign trade policy which is certain to have serious repercussions in the next session of Congress.

Criticism has already come from the Independent Petroleum Association of America and the National Coal Association. Several members of Congress have also expressed their hostility, including Rep. Wesley E. Disney of Oklahoma. The I.P.A.A. statement, issued by Gen. Counsel Russell B. Brown, hinted the agreement was a deal between the State Department and certain major oil companies interested in increasing imports, while John D. Battle, executive secretary of the National Coal Association, declared the coal industry will continue its fight to keep out low-priced fuel oils.

Petroleum is the only competitive product affected by the Venezuelan agreement, as the other concessions by the United States are wholly on tropical products not produced in this country. The United States agreed to keep on the free list petroleum and fuel oil for ship supplies. But petroleum bears the full brunt of the duty concessions made in return for reductions in Venezuelan duties on manufactured products.

The reciprocal trade agreement program has been under increasing criticism in Congress. The law under which United States duties and import taxes may be reduced through trade agreements with other countries expires on June 12, 1940, so congressional opposition will come to a head during the next session. It is believed the law will either be permitted to lapse or be drastically amended, perhaps by requiring Senate ratification of any trade agreements, and there may even be an attempt to repeal the law before June to prevent the State Department from concluding agreements now under negotiation. Major opposition centers with members of Congress from agricultural states.

The theory of the reciprocal trade agreement program is that all American industry and agriculture will benefit through increases in export trade and that our exports can be increased only by permitting other countries to sell more goods in the United States. It is argued the general increase in business will more than compensate for the hardships faced by a few concerns through somewhat larger increases of certain imports. The State Department usually has been careful in selecting its duty cuts and limiting them by quotas and tariff classification to make the increased imports as little as possible in direct and widespread competition with American producers, but some domestic industries have been injured to some extent in each of the 22 trade agreements.

In announcing the oil tax cut in the Venezuelan agreement, the State Department made a strenuous attempt to justify the increased imports on the basis of conservation and the expected resulting increase in American exports of other commodities to Venezuela. A point was made that the reduction in tax applies only to a quota equal to 5 per cent of domestic runs to stills on the theory this will prevent a huge flood of imports, although it is obvious from the department's statement this quota is very much larger than average annual imports during recent years.

The State Department points out that petroleum represents between 84 and 90 per cent of Venezuela's total exports, and the United States supplies about one-half of Venezuela's imports, leaving the conclusion that the reduction in import tax will result in much larger increases of American exports to that country.

## ELECTRICAL LOGGING

*(Continued from Page 93)*

the observers. The recording and control equipment in the trailer is connected to associated parts on the derrick floor through a set of electrical weatherproof cables. In addition to supplying leads for the main recording circuit, these cables also provide for communication between the trailer and the derrick floor and for automatic operation of the recording equipment as the hole is being drilled.

The kelly has been constructed to contain an electric cable which connects to a brush box mounted at the top and immediately below the swivel. The electrical circuit for electrical logging is established through the brush box to the bit by means of a section of cable built into each joint of drill pipe. This cable is held inside a small conduit brazed to the inner periphery of the pipe. With the exception of the conduit, the drill pipe is entirely standard. Electrical connection is made between joints by means of specially designed pairs of electric terminals integrally fixed and permanently mounted in the tool joints. When a tool-joint pin and box are screwed together, the two terminals engage and automatically establish the circuit and insulate the conductor from the mud stream. In order to accommodate the terminals, tool joints have been altered but deviate only slightly from conventional design. Pipe is handled on the derrick floor exactly like any standard drill pipe. No special operations are required and no precautions are necessary for keeping the terminals clean or dry.

To permit the bit to function as an electrode it is necessary to insulate the bit from the drill pipe. This is accomplished by means of a specially designed insulated drill collar. The drill collar contains a 10-ft. insulating section immediately above the bit. This insulation is a bakelite covering. Insulation of this length is for the purpose of allowing the bit to function with satisfactory sensitivity, affected to a minimum extent by the mud stream. Bits used are standard and may be either of the drag or rock-bit type.

A testing switch of ingenious design is incorporated in the circuit. It is mounted in a sub whose place in the drill string is immediately above the drill collar. The operator in the trailer can by means of control apparatus at his disposal test the insulation and continuity of his entire circuit from the trailer to the drill collar. Any leakage of consequence of any cable or automatic terminals can be quickly detected.

The chief obstacles to overcome in the development of this special equipment were mostly mechanical. Of course, the most important problem of all was securing suitable and satisfactory insulation. Obtaining this, however, was again primarily a mechanical problem. One of the major problems was designing and constructing the terminals suitable to withstand the extremely severe service encountered in rotary drilling and in handling of drill pipe on the derrick floor. The job of brazing the conduit to the inside of the drill pipe, done at the pipe mill, was a difficult one. The drill collar covered with ¾-in. wall of bakelite stands the wear in the hole satisfactorily. The bakelite used on the drill collars was the canvas laminated type impregnated with the usual phenolic resin. This bakelite insulation is molded onto the drill collars in steam platen presses. The top sub of the drill collar is screwed onto bakelite threads and these threads must necessarily take all the strains of drilling just as any other threaded joint in the drill stem has to. No trouble with it has been experienced so far.

Results obtained have been quite similar to those obtained with other electrical-logging methods. Some interesting differences have been noticed; these for the most part and as might well be expected have had to do with the contamination of porous formations by the infiltration of drilling fluids. Considerable emphasis is placed on the point that an electric log taken of freshly drilled formations before they are contaminated should be regarded as particularly significant. It has been found necessary so far to keep an operator on duty at all times. The equipment is not so complex but that drilling crews might eventually be trained to operate it satisfactorily; however, interpretation of an electric log is quite technical and therefore in itself may always justify and make desirable the presence of an experienced observer if maximum benefit is to be derived from the log.

*Left: Interior of house trailer showing permanent mounting of recording and control apparatus. Right: Kleiner well at Haskell, Tex., conveniently located near geologist's sample house*

# Wolverton-Ickes Colloquy Is Feature of Cole Hearings

By HENRY D. RALPH

WASHINGTON, D. C., Nov. 13.—Groundwork in support of the Cole bill (H.R. 7372) for establishment of federal standards for oil conservation was laid during the week by a group of federal officials appearing before a subcommittee of the House committee on interstate and foreign commerce headed by Rep. William P. Cole, Jr., of Maryland.

These were the first hearings of the subcommittee since the House last authorized it to make an investigation of the petroleum industry, particularly conditions relating to conservation, and to bring up to date the findings of the 1934 Cole oil study. The committee will resume its hearings at New Orleans about December 12. Chairman Cole said state regulatory agencies would be given an opportunity at that time to answer Secretary Ickes' statements that they are not doing a "complete job" in reducing avoidable waste of petroleum. Before meeting at New Orleans the committee will inspect the new oil fields in Illinois and make brief stops in Oklahoma and Texas. It will not hold hearings in California

### Attempt to Build Up Case

The government officials appearing as witnesses attempted to build up a case for federal regulation because of the necessities of conservation and national defense. The chief witness was Secretary Ickes, and others were spokesmen for bureaus of the Department of Interior, National Resources Planning Board, and the Army and Navy.

Judging from questions asked by the five-man subcommittee, the group as a whole is not enthusiastically supporting the bill which its chairman introduced at the request of the Interior Department. The most persistent questioner was Rep. Charles A. Wolverton, of New Jersey, who appeared sympathetic with the idea of conservation but skeptical of the provisions of the bill. The two big questions which appear to be troubling the committee are the constitutionality of the measure and the effect on consumer prices of close regulation of oil production. Secretary Ickes promised to have the solicitor of his department make a thorough study of the constitutionality, and both he and other witnesses from his department insisted federal control should extend only to the prevention of avoidable waste and should not under any circumstances be used to regulate production in relation to demand or prices.

If a guess may be hazarded so early, the subcommittee will not recommend enactment of the Cole bill in its present form. If it proposes any legislation it will recommend more cooperative action by oil-producing states as a check against the exercise of autocratic control by the Interior Department in conservation measures, and will also suggest legislation of broader scope to deal with marketing problems as suggested at the hearings of the Temporary National Economic Committee.

Secretary Ickes presented a prepared statement in defense of the bill and submitted to extensive questioning. The gist of his statements was that the public interest requires some federal action to prevent unnecessary waste of an exhaustible and irreplaceable resource which is the foundation for our industrial economy and national defense. He pointed to the failure of California and

*HAROLD L. ICKES*

Illinois to enact conservation legislation as proving that it cannot be left to the states without some measure of federal supervision.

Expressing his "personal opinion," Secretary Ickes declared: "I think it would be in the interest of sound national policy to reduce, possibly drastically, our exports of oil. It is a matter for the consideration of the administration and, so far as I know, it has not been considered."

Immediately before this Secretary Ickes had told Chairman Cole "there will likely be a much greater demand from foreign countries as a result of the war. It may have the effect of increasing prices both as to crude and gasoline but I don't know and this is only speculation on my part."

Representative Wolverton took up the estimates of proven oil reserves and told Mr. Ickes the department ought to have a better idea of this than an opinion based upon what they had read and A.P.I. figures. This, he said, was evident from statements of Interior Department witnesses. Secretary Ickes called upon E. B. Swanson, of the department staff, who said the government has no facilities of its own for determining recoverable oil reserves. If there was such a facility they would not have to depend on other sources believed to be reliable but in which they do not participate.

Mr. Wolverton said they should know what the supply is, that it has been increasing in recent years, and if conservation is based upon exhaustion the federal Government should know what the reserves are. He was "astonished" to learn that the Government has no means of ascertaining this.

### Anyone Can Speculate

Mr. Ickes replied that the Geologic Survey answered as accurately as anyone could what the reserves are, that anyone can speculate on it and the belief in the Interior Department on the basis of the present known oil reserve supply and present consumption was there was a 15-to-20 year supply. The secretary knew of no way to get these figures except from those who have discovered the oil and are producing it. "We have neither the facilities, the money or the authority to find out what we would like to know. I think it would be very desirable. I think we could rely with pretty complete confidence on figures of known recoverable oil upon industry figures; potential or undiscovered supplies are something different."

"Conservation is not based on supply and demand," the secretary continued. "There is no rationing of gasoline in this country but there ought to be a proper apportionment. We don't propose to limit production except in Illinois, where it appears they are producing more than ought to be produced as among the oil-producing states. I define conservation as prudent, wise use, not limited use—use without waste, using what this generation needs without wasting it for the next generation."

Mr. Wolverton said prudent use would include elimination of economic waste. Mr. Ickes interjected that "the amount put in storage ought to be taken into consideration in the next month's production."

Discussion turned to the August shutdown. Mr. Wolverton said the reasons advanced in justification of the shutdown "were totally foreign" to the purposes which the committee had in mind when they reported the resolution providing for the interstate oil compact. It was at his insistance, Mr. Wolverton said, that the "safety valve to protect the public" against its use to influence prices was inserted in the law.

Mr. Ickes said the shutdown amounted to "using conservation to affect prices. I didn't think it proper at the time and said so publicly."

Mr. Wolverton said the action indicated stabilization of prices, not conservation was the motive.

"I won't dispute that," Mr. Ickes rejoined. "That action is a very sound and eloquent argument for a federal conservation bill. . . . I don't think there ought to be any power to fix prices under the bill or do anything which would have that effect. My

theory is that if and when the U. S. Government goes into price fixing it should not do it under a subterfuge, and, if it does do it, do it frankly.

"I think they made a mistake in Texas. The danger of a thing like that is it discredits the whole conservation idea."

Secretary Ickes commented upon the rejection of the Atkinson oil-control bill by the people of California, the second time they had defeated a conservation law. "That is pretty good notice that we can't expect the second-largest oil-producing state to do anything about it; meanwhile the waste is going on and will continue."

Regarding industry reaction to the Cole bill, Mr. Ickes said, "An industry wants to run its own business in its own way regardless of the effect upon the public. The nation owes it to itself and future generations to see to its conservation; if to do so makes me a dictator, I'm willing to be called a dictator."

### Price Control

Concerning the suspicion that the bill might be used to control prices, Mr. Ickes declared: "If there is any such language I hope the committee will find it and strike it out, and if the committee and Congress can find any other way to conserve oil and gas I would like to join in the support of it."

"Would the bill have any effect on production as it is at present?" asked Mr. Wolverton.

"It would still be up to the states to determine the amount of oil to be produced, provided there is no waste," Mr. Ickes answered. . . . "It won't seek to limit production but only prevent avoidable waste. . . . There isn't much surface waste, but if there is it should control that. From my own point of view oil companies might avoid putting so much oil in storage aboveground on account of the waste."

Mr. Wolverton said expressions not only from the industry but the states were that the bill would place the Government in control of oil. "I don't think so," said Mr. Ickes. Mr. Wolverton cited unit operation as a possible means of doing so. This could be enforced only on the public lands, the secretary explained. Mr. Wolverton maintained that since only 185 out of 3,000 existing pools were operated on a unit basis there must be some difficulty about it. Both agreed there was no relation between waste and unit operation.

Continuing, Mr. Wolverton took up oil-gas ratios as to which Ickes had testified there was a wide variance among the states. Mr. Ickes agreed that if the conservation commissioner authorized by the bill would find there were excessive ratios he could order the operator to desist and upon refusal the Government would take the operator into court. "There is no use having a bill if there is no power to enforce it." He added, as to unit operation that they could not enforce it against the contractual relationship of people who already have rights in a pool. "Even under unit operation all could agree to waste."

Answering Mr. Wolverton's query whether lack of state cooperation was the reason for the bill, Mr. Ickes declared: "I don't think the states have done all they might have done." . . . I am not complaining as to the lack of cooperation; none is compelled, but I do complain about the waste. They cannot have cooperation where, as in California and Illinois, there are no conservation laws. Illinois will be in favor of conservation after the flush production is over. There is a good deal of politics mixed up with oil in Illinois."

Mention by Mr. Ickes that "Illinois is in bad shape" evoked the comment from Committeeman Edward A. Kelly (Dem., Ill.) that landowners will cooperate but they do not want the major companies to dominate the administration of any law enacted. "In the absence of an Illinois law the federal Government could go in to prevent waste," Mr. Ickes said.

The final witness was Glenn E. McLaughlin, professor of economics, Hunter College, New York, whose presentation closely paralleled his statement to the Temporary National Economic Committee along with other spokesmen for the National Resources Commission.

The need for federal legislation to eliminate waste was minimized by Harold C. Miller, senior petroleum engineer, Bureau of Mines, San Francisco, Calif. Federal regulation would be beset with just as many difficulties as encountered by the states in the administration of waste and proration laws. Opinion also was expressed by Mr. Miller, a member of the field staff as distinguished from an office man in Washington, that the states are doing a good job of regulation and that federal legislation, if enacted, could be applied only to future fields.

The witness pointed out that most, if not all, of the wasteful practices listed in the Cole bill are conceded by the industry and sought to be avoided or eliminated wherever it is possible.

Mr. Miller declared he was unable to see where it would be any easier for the federal Government to enforce these things than it is for the states. He indicated that the trouble would not come from the engineering aspect so much as from the fact that they would still have the rule of capture to overcome which would throw the subject matter into the courts. "One spacing pattern won't suit all of the country," he pointed out. It is too late now to remedy the spacing situation in the East Texas field or in California and that the federal law would have to operate largely in new fields. "To regulate only the new fields may place a handicap on new development and put new fields at a disadvantage.

Arno C. Fieldner, chief, technological branch, Bureau of Mines, said we could not look forward to byproduct oils to furnish any material amount of gasoline. Gasoline produced from coal, would cost 18 cents per gallon under present conditions with 16 cents the minimum cost and 12 cents a possible cost in the distant future. Even using all of the bituminous coal produced in the country in one year, 440,000,000 tons would not produce more than 5 per cent of the amount of gasoline produced today from petroleum. Cost of producing synthetic gasoline from coal will run 3 or 4 times as much as that produced from crude oil and we cannot expect any great reduction in costs.

Other witnesses were, H. A. Breakey, associate economic analyst, Petroleum Economics Division, Bureau of Mines, who discussed the motor fuel situation, and Arthur H. Redfield, Petroleum Economics Division, who presented an analysis of imports and exports.

A. J. Kraemer, senior refinery engineer, Bureau of Mines, called attention to the definite trend toward moving refineries from inland to coast points, notably the Gulf Coast. This trend is not apparent in the Rocky Mountain area, due principally to demand for asphalt for road surfacing in the national parks.

Rear Admiral H. A. Stuart, director of naval petroleum reserves, declared the Navy is extremely anxious to add to naval reserves in proven oil pools and that the Navy's annual peacetime requirements of nine million barrels might amount to five or six times that amount, or even more, in war. Navy requirements have increased materially during the present emergency.

Col. H. K. Rutherford, chief, planning branch, office of the Undersecretary of War, pointed out the Army's peacetime requirements of 1½ million barrels would increase to between ten and twelve million barrels annually in war. Colonel Rutherford estimated war consumption would necessitate having supplies sufficient to meet a 15 per cent increase above the total normal consumption of the country.

The Army's consumption of petroleum is 20 per cent of that of the Navy.

Rear Admiral Stuart thought we should increase our imports and stop all exports. The department is trying to work out the problem of private holdings in naval reserves in California by arranging a suitable exchange of properties, if not, through condemnation. Reservation of tidal oil lands, in California, would add 10 years' peacetime supply and a possible 30 years.

Government leasing policies were discussed by Hale B. Soyster, chief, oil and gas leasing division, Geologic Survey

Spokesmen for the National Resources Commission ran into stiff questioning by Mr. Wolverton. Dr. Ralph J. Watkins predicted unit control is so sound in scientific theory and economics it is bound to come. "Only the Government has the jurisdiction coextensive with the scope of the problem."

# Voters Swamp Atkinson Bill

LOS ANGELES, Calif., Nov. 13.—The Atkinson oil-control bill was swamped at the special election November 7 and thus, for the second time, the voters of California rejected state oil regulation. Latest returns indicate a no vote of 1,721,064 and a yes vote of 1,077,196 and final tabulations will probably increase this margin of 643,868 no votes. This majority was rolled up despite endorsements by President Roosevelt, Herbert Hoover. the Interior Department, Navy Department, War Department and by Secretary Ickes who was in California at the time of the election. The split in the state administration which put Governor Olson on one side and Lieutenant Governor Patterson on the other contributed to the defeat of the measure.

Sponsors of the Atkinson bill announce that another attempt will be made to introduce similar legislation at the next session of the legislature. San Francisco gave the issue a yes majority of 78,681 votes whereas Los Angeles voted no by a margin of more than 600,000 votes. Kern, Fresno, Kings, Orange, Santa Barbara and Ventura counties, which all have producing fields, voted against the measure as did most other counties. This bill was beaten by a larger majority than the Sharkey bill in 1934, although it had a more representative backing from a political standpoint. Pierson Hall, campaign manager for the bill, issued a statement that "Public control of resources is something which must come sooner or later. I prefer to do it by state law rather than by federal statute."

Removal of the uncertainty that has existed during the past several weeks will tend to stimulate development work in several areas. Defeat of this measure will also make it necessary for operators to conform strictly with the voluntary curtailment program. Between December 31, 1938, and October 1, 1939, total stocks on the Pacific Coast were reduced 3,025,480 bbl. or from 157,684,289 bbl. to 154,658,809 bbl. Several large marketers refused to take any position on the bill.

*Francis Minshall, Continental Oil Co., Chester Castle, Texas Co., E. J. Bartosh, Bankline Oil Co., new secretary-treasurer, Albert Gregersen, Texas Co., new president*

# A.A.P.G. Pacific Section Meets in Los Angeles

By L. P. STOCKMAN

LOS ANGELES, Calif., Nov. 13.—The sixteenth annual meeting of the Pacific section of the American Association of Petroleum Geologists and the Pacific section of the Society of Paleontologists and Mineralogists at the Ambassador Hotel in Los Angeles November 10 heard and discussed a number of excellent geological papers. Albert Gregersen, who headed the program committee, was elected president of the Pacific section, succeeding Roy M. Barnes, and E. J. Bartosh, of Bankline Oil Co., was elected secretary-treasurer, succeeding H. D. Hobson. The paleontologists at their meeting at the Clark Hotel November 9 elected James Hammel, of Texas Co., president for the coming year, succeeding W. D. Rankin. Edward Fritz, of Union Oil Co., was reelected secretary-treasurer. One of the finest gestures was the preparation of a testimonial to Ralph Reed, of Texas Co., who has been seriously ill for some time but is now convalescing slowly.

## Geochemical Prospecting

The meeting was opened by Henry A. Ley, national president of the A.A.P.G. Geochemical prospecting, as presented by E. E. Rosaire of Subterrex, was divided into surface and subsurface geochemical prospecting. Surface geochemical anomalies are associated with the presence and areal extent, but not the depth nor the relief, or favorable structure; surface geochemical prospecting is further divided into topsoil and subsoil geochemical prospecting. Subsurface geochemical prospecting relies upon the analyses of well cuttings and cores. It yields information in one dimension, along the vertical.

## Lithological Variations

Paul P. Goudkoff discussed the Delmontian Upper Mohnian strata of the San Joaquin Valley, known for their extreme lithological variations. On the basis of lithological and paleontological studies of material obtained from 150 wells and several surface sections, the whole column has been divided into a number of units representing definite time divisions. An attempt has been made to define the principal types of microfaunal assemblages found in different parts of each unit; to appraise the ecological significance of these types, and to survey their distribution in relation to lithological variations of the sediments of each unit. The paper was supplemented with slides.

Roy Barnes, of Continental Oil Co., president of the Pacific section of the A.A.P.G. presided during the morning and Albert Gregersen, incoming president, presided at the afternoon session on the opening day.

## San Joaquin Valley

W. F. Barbat, of Standard Oil Co., discussed the Pliocene of the San Joaquin Valley area. Attention was called to diastrophic history, geologic occurrence of land vertebrates, and to physical conditions under which the sediments were deposited.

Max Steineke, of Standard Oil Co., discussed Arabian geology and topography and in addition to showing a general map of Arabia presented a motion picture of typical scenes.

Frank Hornkohl presented a paper on "Interpretation of Core Analyses," discussing permeability, porosity, and water saturation of a sand. The larger the diameter of the core sample, the more accurate the determination. Oil saturation is only of comparative value, because in deep samples of light-gravity oils, only the residual oil is present. Permeability and porosity determination for the entire sand area plus bottom-hole pressure readings make it possible to predict fairly accurately the gross barrels per day per foot of sand.

## Columnar Sections

J. Q. Anderson, of Union Oil Co., discussed the "Comparative Columnar Sections of the Domengine-Arroyo Hondo Sandstone Intervals Between Cantua Creek and Waltham Canyon in the Coalinga District." This included slides showing 13 hand-leveled surface columnar sections of the Domengine-Arroyo Hondo sandstone intervals, measured at varying distances between Cantua Creek and Waltham Canyon.

Harry Allen presented a paper dealing with "An Eocene Section at Point of Rocks in Kern County," the results of recent field and paleontological work, conducted in an attempt to clarify the problem. Roger Revelle, of Scripps Institution of Oceanography, discussed "Problems of Sediment Transportation Off the Coast of California."

Francis B. Bode presented "Geological Observations in Italian East Africa."

## Recent Discoveries

The final session was an informal symposium on recent petroleum discoveries in California and covered extemporaneous papers and discussions on: (1) Cole's Levee Oil Field, by R. Eckis of Richfield Oil Corp. and G. Gariepy of Ohio Oil Co.; (2) Paloma Field, by R. W. Clark of Western Gulf Oil Co.; (3) Strand Oil Field, by S. A. Menken of Tide Water Associated Oil Co.; (4) Aliso Canyon Field, by C. E. Leach of Tide Water Associated Oil Co., and (5) West Montebello Field, by Vernon L. King and H. M. Preston. Informal papers on East Coalinga and Amerada area, by L. S. Chambers, and Summary of Development of Northern California Gas Fields, by J. R. Dorrance of Texas Co., were read by title. Waldo Nelson read J. R. Dorrance's informal paper on South Mountain View Field.

The meeting of the paleonological group was limited to one paper by Boris Laiming, of Texas Co., on "Some Foraminiferal Correlations in the Eocene of San Joaquin Valley," in which the author presented evidence to prove the value of the smaller foraminifera as a basis for correlating Eocene strata in California.

*Between sessions at the A.A.P.G. meeting*

# PROGRAMS AND MEETINGS

## W.P.R.A. Annual Meeting At Wichita in Spring

The board of directors of the Western Petroleum Refiners Association has selected the place and time for the 1940 annual meeting. A committee composed of R. W. McDowell, F. L. Martin and H. W. Camp was appointed by President Simmons to canvass the mail ballot. A number of cities extended invitations to the association for the meeting and received the consideration of the board of directors. Dates of other meetings in the oil industry and facilities for handling the meeting in the various towns, as well as the locations, were taken into account in making this selection, and the special committee announces the result as follows: Place—Wichita, Kans.; time—March 31, April 1 and 2, 1940.

The Allis Hotel in Wichita was chosen as the headquarters hotel. The committee felt that the favorable location of Wichita would be a strong factor in making the attendance at the 1940 meeting one of the largest in the history of the association.

Plans for an interesting and instructive program are going forward, and preliminary announcements will be made at an early date.

## K.M.A. Operators to Discuss Pressure Maintenance

Operators in the K.M.A. field will hold their second meeting to discuss gas-pressure-maintenance problems November 20 at 10 a.m. at the Kemp Hotel, Wichita Falls, Tex.

John F. O'Donohoe, president of the North Texas Oil and Gas Association, urged every operator to attend and emphasized the importance of the problem.

Mr. O'Donohoe's letter said: "As an operator in the K.M.A. field, I am so convinced of the enormous value of the pressure maintenance in the field that I believe it to be of paramount importance to the future operation of the field.

"We can, by uniform producing methods, and proper return of gas to the reservoir, delay for quite some time the necessity of installing pumping equipment at enormous expense to all operators and, what is more important, increase the ultimate recovery many millions of barrels of oil. . . .

"Pressure maintenance is not an individual problem but a common one and the solution lies in frank discussion in which all operators should be interested."

## A.S.M.E. Medal Awarded To L. M. Goldsmith

The Melville Medal for original work, awarded annually by the American Society of Mechanical Engineers for the best original paper on any mechanical engineering subject presented to the society for discussion and publication, will be awarded to Lester M. Goldsmith, chief engineer of Atlantic Refining Co., December 6, during the annual meeting of the society in Philadelphia. This is the first occasion on which the medal has been awarded for a paper on any subject in the field of naval engineering.

*LESTER M. GOLDSMITH*

The award of the Melville Medal to Mr. Goldsmith is in recognition of his paper on "The High-Pressure High-Temperature Turbine-Electric Steamship the J. W. Van Dyke," the 18,100-ton welded oil carrier added to the Atlantic Refining Co. fleet in 1938. The paper was read by Mr. Goldsmith at the 1938 annual meeting of the Society of Mechanical Engineers.

Two years after his graduation in 1914 from the Drexel Institute of Technology as an electrical engineer, Mr. Goldsmith entered the employ of Atlantic Refining Co. as mechanical draftsman. In 1934 he was appointed manager of the engineering and construction department. He was appointed chief engineer in 1937. He has been in charge of several major construction operations, including the company's new refinery at Atreco, Tex. He is a vice president and director of Atlantic Pipe Line Co. and a director of Atlantic Oil Shipping Co., subsidiaries of Atlantic Refining Co. He is a member of the American Petroleum Institute, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Society of Naval Engineers, Society of Naval Architects and Engineers, Society of Automotive Engineers and American Welding Society.

## Field Credit Association Installs New Officers

Approximately 20 members of the Oil Field Division of the Houston Association of Credit Men, Inc., attended the banquet at Houston, Tex., last week to inaugurate new officers of the association. G. B. Coleman, of the Bowen Co., was elected chairman, succeeding Walter Cooney of Baker Oil Tools. A. D. Hildreth, of the Plowden, was elected vice chairman, and Eliot Johnson, of the Schlumberger Well Surveying Corp., was elected as parliamentarian. The association was formed a year ago to provide a medium for generally constructive credit cooperation and standardization of credit practices within the industries.

## Petroleum Credit Men to Meet In Tulsa Next Year

M. C. Roberts, credit manager for Tide Water Associated Oil Co., has advised Tulsa Chamber of Commerce officials that the petroleum-refining division of the National Association of Credit Men will hold its 1940 convention in Tulsa.

Mr. Roberts will be general manager of the program for the meeting, which will attract credit managers from oil companies throughout the United States. He will be assisted by others in similar capacities with local firms.

# CALENDAR OF EVENTS

### November

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Providence, R. I., November 15-17.

CALIFORNIA NATURAL GASOLINE ASSOCIATION, annual fall meeting, Los Angeles, Calif., November 17.

### December

SEVENTEENTH EXPOSITION OF CHEMICAL INDUSTRIES, Grand Central Palace, New York, December 4-9.

WEST CENTRAL TEXAS OIL AND GAS ASSOCIATION, Mineral Wells, Tex., December 11.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Philadelphia, Pa., December 4-7.

PETROLEUM ELECTRIC POWER ASSOCIATION, eleventh annual conference, Texas State Hotel, Houston, Tex., December 14-15.

### January 1940

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting, Book-Cadillac Hotel, Detroit, Mich., January 15-19.

### February

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, New York, February 12-15.

### March

AMERICAN PETROLEUM INSTITUTE, Mid-Continent district, Division of Production, Wichita, Kans., March 14-15.

AMERICAN PETROLEUM INSTITUTE, Southwestern district, Division of Production, Houston, Tex., March 28-29.

### April

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, twenty-fifth annual meeting, Stevens Hotel, Chicago, April 10-12.

AMERICAN PETROLEUM INSTITUTE, eastern district, Division of Production, Columbus, Ohio, April 11-12.

NATIONAL PETROLEUM ASSOCIATION, semi-annual meeting, Cleveland Hotel, Cleveland, Ohio, April 18-19.

### May

NATURAL GASOLINE ASSOCIATION OF AMERICA, annual convention, Hotel Tulsa, Tulsa, May 15-17.

INTERNATIONAL PETROLEUM EXPOSITION, Tulsa, May 18-25.

PETROLEUM INDUSTRY ELECTRICAL ASSOCIATION, Dallas, Tex.

# International

## Mexico . .

### Mexican Manager Says Market Is Building Up

MEXICO is gradually building up an export market for its petroleum, has recently made sales in the United States and other countries, and is maintaining its oil production at a normal rate, it was declared by Prof. J. Silva Herzog, general manager of the Mexican Oil Distributing Agency, at a press conference at the Mexican Embassy in Washington. He was returning to Mexico after a 2-week trip in the United States arranging for the sale of oil and purchase of refinery and storage equipment. He did not comment on the deadlock over the confiscation of properties, but declared he saw no future difficulties for sale of Mexican petroleum in this country. He also declined to comment on the trade agreement with Venezuela, although this should be an aid to sales of Mexican oil here since the reduction in the import tax applies equally to Mexican oil until imports from all countries reach a total of 5 per cent of domestic runs to stills for the preceding year.

In a prepared statement Professor Herzog declared Mexico desires to sell only to democratic nations, and supplemented this with the statement that no sales have yet been made to Japan, and no shipments have been made to Germany since the outbreak of the war. He admitted the Davis contract under which Mexican oil had been going to Germany is inoperative and virtually canceled. Several purchasers in the United States, he said, are now taking Mexican oil through a number of ports, both for internal consumption and for reexport after refining in bond; but he declined to identify the purchasers or the amounts. He would not say whether any sales have been made in England, but declared some spot sales have been made in France and considerable sales have been made to Italy under a barter arrangement. He declared that some sales are being made to Scandinavian countries on a spot basis and that considerable markets have been developed in Brazil, Uruguay, Chile, and Central American nations. During recent months all sales have been made at market prices, he insisted. He declared that production of petroleum in Mexico is now at the rate of 150,000 bbl. per day, which is higher than the rate in 1938, and about the same as the 1937 average production which was the largest since 1928.

## Tankers . .

### Fifteen Placed Under The Flag of Panama

FIFTEEN tankers have been or will be removed from United States registry and placed under the flag of Panama by Standard Oil Co. of New Jersey in an adjustment of its tonnage to meet limitations imposed against American boats by the revised neutrality act.

Application to change the registry of the vessels was made late in September and approval was given by the Maritime Commission in Washington in October. So far, five boats have been converted to Panamanian registry. Four of the five vessels are now at sea with Canadian crews and the other is manned by a Danish crew.

Title to the boats is being placed in the Panama Transport Co., a subsidiary of Standard of New Jersey. Panama Transport Co. was formed in 1935 to take over ships of the New Jersey company formerly under German registry. With transfer of the 15 vessels the Panama Transport fleet will consist of 38 tankers.

The ships that are being transferred have an average age of more than 20 years. Some of the ships have been tied up at Baltimore for a long period preparatory to being sold as scrap.

The prohibition against voyages to belligerent countries imposed by Norway against vessels registered in that country caused a serious dislocation of trans-Atlantic tonnage. As a result, virtually all of Norway's 272 tankers with 2,117,381 deadweight tonnage are tied up in either home or foreign ports. Some have been able to capture business in directions other than Europe but most of the 272 tankers were previously engaged in trans-Atlantic trade. (See photo on Page 88.)

## Brazil . .

### Planning a 4,000-Bbl. Refinery at Nictheroy

PLANS are under way for construction of a 4,000-bbl. capacity refinery at Nictheroy, capital of the State of Rio de Janeiro, Brazil. Word from Rio de Janeiro last week that the contract had been executed could not be confirmed in New York but it was understood negotiations are in advanced stages.

The Nictheroy refinery will be the first constructed under Brazil's national oil policy. The plant will be a complete combination unit including topping and cracking facilities. The Brazilian Government is planning to spend approximately $2,600,000 on it. Early this year Brazil issued decrees requiring that all petroleum companies be owned 100 per cent by nationals.

Standard Oil Co. of Brazil, subsidiary of Standard of New Jersey, finished a modern refinery at Sao Paulo, Brazil, just before the national oil policy was launched. The refinery has capacity of 2,160 bbl. per day, but has never been operated. The government is planning construction of another refinery at Sao Paulo and it is thought likely Standard of Brazil will dispose of its facilities to the government.

At present Brazil is entirely dependent on imported petroleum, but the government has launched a drilling program in the State of Bahia and in the State of Alagoas. Three tests have been started in Alagoas and two are drilling in Sao Salvador, State of Bahia, about 700 miles northeast of Rio de Janeiro.

Brazil is reported to have entered an agreement with Mexico covering about $4,000,000 worth of crude oil. Deliveries from Mexico will start about the middle of next year and will be made at the rate of 10,000 bbl. per day.

## Colombia . .

### First Tanker Carrying Oil From Barco Sails

THE first tanker of Barco concession crude oil was loaded and moved from Covenas, Colombia, November 9. Destination of the cargo was not disclosed, although it went to a South American country. The small refinery at Petrolea capable of running 500 bbl. per day is now in operation. In the topping operation of the refinery 54 per cent gasoline is recovered. The oil is entirely free from sulfur and requires no sweetening treatment.

## Argentina . .

### Buying Tank Cars to Import Bolivian Oil

THE Argentine Government has authorized the State Railways to purchase 200 tank cars in the United States at a cost of $447,600 for the purpose of transporting Bolivian oil to national refineries.

The government railroad organization has been building a line to the Bolivian frontier at Yacuiba over which the tank cars will operate. Bolivian production was confiscated in 1937 from Standard Oil Co. of Bolivia, subsidiary of Standard of New Jersey. The government asserted the company had defrauded the national treasury of about 3,000,000 Bolivian pesos.

The property seized covered approximately 2,500,000 acres, mostly in the foothills of the Andes between Santa Cruz and Villa Montes. Several wells had been drilled on the property at the time of confiscation, but most of them had been closed due to lack of market outlet. Since confiscation the government has carried on a moderate development program, but the potentialities of the country as a producer of important quantities of oil remain to be proven.

## Cuba . .

### New Corporation Is Drilling More Wells

A NEW corporation, known as "El Valle de Motembo, S.A." Aguiar y Obrapia, has been formed in Cuba to carry on exploitation of property held in the Motembo naphtha distillate field. The firm has completed its first well producing about 200 gal. of distillate per day.

Benjamin Fernandez Alvarez is president of the new company. Dr. Enrique Loynez Munoz is vice president, Luis Galbis y Ajuria treasurer and Carlos Manuel Velez vice treasurer.

Cia. Petrolera Nacional de Motembo is reported to have recently imported another rig for development of its Waldo lease in the Motembo area and is drilling Nos. 11 and 12.

# Combining Bending and Hoop Stresses to Determine Collapsing Pressure of Oil-Country Tubular Goods

By WALTER C. MAIN
Youngstown Sheet & Tube Co., Los Angeles, Calif.

**ABSTRACT**

**This is a new approach, from a theoretical standpoint, to the problem of collapsing pressures of oil-country tubular goods.**

**The paper points out the limitations of present formulas, and suggests a method whereby the two existing types of rational formulas might be combined to give a result which is also rational and will apply throughout the entire range of tube proportions regularly used for casing, drill pipe, and tubing.**

**Although the equation which is developed by this method is cumbersome, it should aid in clearing up some of the mistaken notions on this problem, and help to straighten out the controversy on safe setting depths of oil-country tubular goods from a collapsing point of view.**

The author points out the obvious limitations of:

1. So-called "elastic" formulas similar to the one of Timoshenko:

$$P=\frac{2E}{1-\mu^2}\cdot\frac{1}{\left(\frac{D}{t}\right)^3}$$

2. Hoop-stress formulas such as Barlow's:

$$P=\frac{2St}{D}$$

3. Empirical solutions such as Johnson's parabolas, the Mannesmannrohren Werke formula, etc.,

$$S=\frac{3EP}{4E-2P(1-\mu^2)\left(\frac{D}{t}-1\right)^3}+P\sqrt{\frac{2(1+\mu)\left(\frac{\frac{D}{t}}{\frac{D}{t}-2}\right)^3+2(1-\mu)}{\left[\left(\frac{\frac{D}{t}}{\frac{D}{t}-2}\right)^3-1\right]}}$$

And, using the derivations of Bresse for bending stresses modified to fit the maximum-strain energy theory, together with the maximum-strain energy equation for hoop stresses, he sets up the above equation.

Even though cumbersome, this equation should aid in clearing up some of the mistaken notions on the collapse problem of oil-well casing, and should aid in obtaining the safe setting depths for oil-country tubular goods.

In order to obtain a general picture of the problem of collapsing pressures, it is necessary to review briefly some of the previous efforts at a solution.

### Bending-Stress Formulas

The equations shown in Fig. 1—which erroneously, in the writer's opinion, have become accepted too generally—are based on the collapsing action of external pressures on thin, and usually short, hollow cylinders; and all take the form very ably illustrated in Mr. Clinedinst's paper.[1]

You may call these "thin-tube formulas" if you wish; but for the purpose of this discussion, we shall refer to them as "bending-stress formulas." This name is based on the method of their derivation, and they apply where the bending stress is the predominating influence in collapse. The term "elastic" or "envelope" curve is misleading, and should be avoided.

Shorn of those terms relating to the number of lobes into which the tube collapses and to the "end effects" of short cylinders, these equations are:

**(Levy, 1884)** $$P=\frac{2E}{1-\mu^2}\cdot\frac{1}{\left(\frac{D}{t}-1\right)^3}$$

**(Clinedinst, 1939)** $$P=\frac{2E}{1-\mu^2}\cdot\frac{1}{\frac{D}{t}\left(\frac{D}{t}-1\right)^2}$$

**(Timoshenko, Sturm, et al.[2])** $$P=\frac{2E}{1-\mu^2}\cdot\frac{1}{\left(\frac{D}{t}\right)^3}$$

Where:

$P$ = pressure
$E$ = Young's modulus
$D$ = outside diameter, inches
$t$ = thickness, inches
$\mu$ = Poisson's ratio

And here is another:

$$P=\frac{2E}{1-\mu^2}\left(\frac{t^3}{D^3}-\frac{t^4}{D^4}\right)$$

obtained simply by substituting Sturm's value for stress in Lame's formula.

It should be noted that in his report* as chairman of the manufacturers' subcommittee, J. J. Dunn finds Clinedinst's curve to give slightly high results compared with tests; therefore, he multiplied it by 0.95. If the last formula given above were used, and also a more accurate value of Poisson's ratio (0.26), then this last formula would have filled the bill very nicely.

However, injecting this last formula into the already complicated picture should not be taken seriously. It is merely intended to demonstrate the futility of this line of attack. The point is that here we have a group of curves of almost the same shape, varying from each other by a small percentage, that apply only through a limited range of $D/t$ values, and even then give approximate relations.

The pressure determined by any of these equations is known as the "critical pressure"; and we are told that, if the yield point of the steel is high enough, collapse will occur at these pressures.

One good way of testing such equations—particularly to determine the range in which they are valid—is to take values of $D/t$ that we know something about, and solve for pressure.

For example, let us take a solid round bar, i.e., a right circular cylinder whose $D/t$ ratio is 2. Obviously, there is something wrong with these expressions for this, and also for very thick-walled tubes, because we find, where $D/t$ is 2:

| | (Lb. per sq. in.) |
|---|---|
| Levy's equation gives | 64,000,000 |
| Clinedinst's equation gives | 32,000,000 |
| Timoshenko, Sturm, and others | 8,000,000 |
| And the last equation | 4,000,000 |

These vary altogether too much, and they are all obviously incorrect.

On the other hand, suppose we take $D/t = 100$ Then we find:

| | (Lb. per sq. in.) |
|---|---|
| Levy's equation gives | 66 |
| Clinedinst's equation gives | 65.3 |
| Timoshenko, Sturm, and others | 64 |
| And the last equation | 64.6 |

We know from tests that these results are pretty

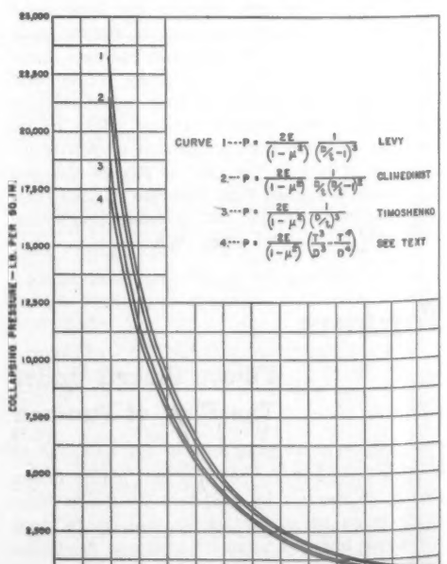

CURVE 1---P = 2E/(1-μ²) 1/(D/t-1)³ LEVY
2---P = 2E/(1-μ²) 1/(D/t)(D/t-1)² CLINEDINST
3---P = 2E/(1-μ²) (t/D)³ TIMOSHENKO
4---P = 2E/(1-μ²) (t³/D³ - t⁴/D⁴) SEE TEXT
COLLAPSING PRESSURE—LB. PER SQ. IN.
RATIO OF OUTSIDE DIAMETER TO THICKNESS, D/t

*Fig. 1—Bending-stress formulas*

**A.P.I.** — **Presented before annual meeting, Chicago, Ill., November 13-17, 1939**

*New Orleans meeting, May 1939; A.P.I. Production Bull. No. 223, Exhibit "J," p. 148-55.

accurate, and they do check each other fairly well.

Carrying this analysis further, you will find that any of these "bending-stress formulas" apply without serious error to thin tubes in the range above $D/t = 50$. Your attention is directed, however, to the fact that the range of $D/t$ in all casing sizes is from 12 to 40.

In passing, we should mention the excellent teachings of Rudolph Mayer-Mitka[3] and R. Von Mises.[4] Their work, however, is also applicable only to thin tubes, as are the other "bending-stress formulas." The Von Mises equation, for example, is very useful when equal radial and end pressures are exerted on right circular cylinders when the $D/t$ ratio varies from 100 to 2,000.

## Hoop-Stress Formulas

Now there is another group of equations that gives the relation between stress, pressure, and tube proportions. These equations we will call the "hoop-stress equations" (see Fig. 2). They approach the collapse pressure very closely when the $D/t$ ratio is low; i.e., when the tube does not collapse, but instead it starts decreasing more rapidly across all diameters—immediately when the yield strength of the tube wall is reached. They are most useful for internal pressure, and are valid up to the yield strength from that direction.

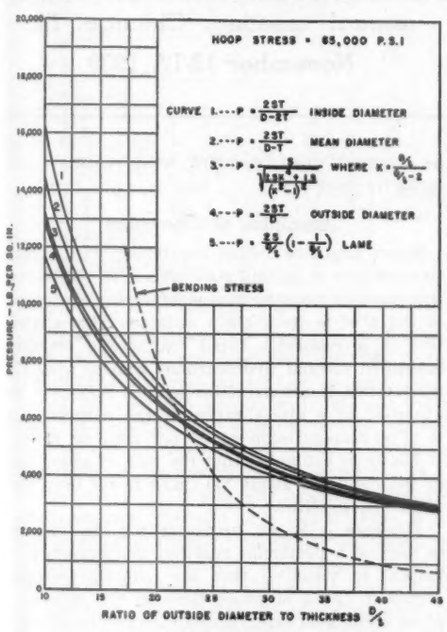

HOOP STRESS = 85,000 P.S.I
CURVE 1.---P = 2ST/(D-2T) INSIDE DIAMETER
2.---P = 2ST/(D-T) MEAN DIAMETER
3.---P = S/√(2.56K²+1.8/(K²-1)²) WHERE K = D/t / D/t - 2
4.---P = 2ST/D OUTSIDE DIAMETER
5.---P = 2S/D/t (1-1/D/t) LAME
BENDING STRESS
PRESSURE - LB. PER SQ. IN.
RATIO OF OUTSIDE DIAMETER TO THICKNESS D/t

*Fig. 2—Hoop-stress curve*

These equations are:

Outside diameter (Barlow). $P = \frac{2st}{D}$

Mean diameter ..... $P = \frac{2st}{D-t}$

Inside diameter ..... $P = \frac{2st}{D-2t}$

Lame ..... $P = \frac{2st}{D}\left(1-\frac{t}{D}\right)$

Maximum-strain energy ...

$$P = \frac{S}{\sqrt{\frac{2(1+\mu)k^2+2(1-\mu)}{(k^2-1)^2}}}, \text{ where } k = \frac{\frac{D}{t}}{\frac{D}{t}-2}$$

Others have brought up the question of the rigorousness of the derivation of all of these formulas. This writer cannot accept any theory other than the postulates of the maximum-strain energy theory. Please believe that this stand is not taken because formulas based on this theory are more complex than some of the others, but because when the derivation depends—as it inevitably does—on the work done by the forces involved, then the sum of the energies seems to be the only logical method of evaluating the expected result.

You will observe from the graphic representation of these "hoop-stress formulas" in Fig. 2 that they all cross the "bending-stress-formula" curves in the region of $D/t = 21$ to 23. Above those values for $D/t$ we know that they represent impossible pressures.

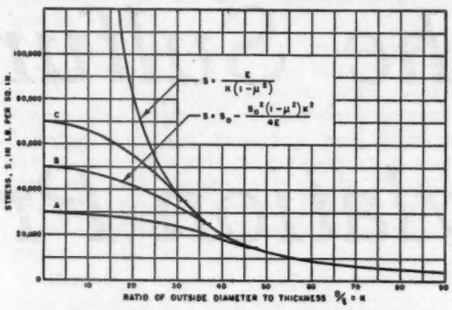



*Fig. 3—Illustrating Johnson's parabolas*

By applying the same tests used on the "bending-stress formulas" you will find that these "hoop-stress formulas" help us only when the tube does not collapse normally, and apply to external pressure only for very thick tubes.

Again we wish to remind you that oil-country tubular products are generally thinner than those noncollapsing tubes, and unfortunately they do collapse.

## Empirical Solutions

There is a third group of relations that must be examined. They purport to show how stresses and pressures vary over the range of $D/t$ values in which we are interested.

Fig. 3 illustrates one of the earliest, well-thought-out attempts to span the gap between thick and thin tubes, between bending-stress and hoop-stress formulas. The author of these branch curves is J. B. Johnson, and they were intended originally to apply to long columns. He argued that test results indicated some sort of curve, rather than a straight line originally suggested by Tetmajer. He noted that a hyperbola could be drawn tangent to the ever-inviting bending-stress-formula curve. And so he proposed the Johnson parabolas, which have their vertices at the yield strengths of the various steels and become tangent to the bending-stress curve when the stress is half the yield stress.

The formula for Johnson's parabolas is:

$$S = S_y - \frac{S_y^2(1-\mu^2)\left(\frac{D}{t}\right)^2}{4E}$$

Where: $S_y$ is the yield strength of the steel.

In the upper graph of Fig. 4 is shown the familiar "bending-stress-formula" curve—branching from which are two curves representing different ideas as to how the stress varies in the territory in which we are interested. The upper curve is the "Johnson parabola" described hereinbefore.

The lower curve is Stewart's[5] empirical formula:

$$S = \frac{37{,}000}{1+0.00084\left(\frac{D}{t}\right)^2}$$

based on test data. The test results seem to be enclosed mostly within these two. It should be pointed out, however, that this writer does not admit that the calculation of stress in plotting these points is correct. If it were correct, then Stewart is on the safe side, and Johnson on the optimistic side.

The lower graph illustrates some of the test results on casing sold a West Coast customer, plotted against the curves of Jasper and Sullivan.[6] These are better illustrated in Fig. 5. No equations for these branch curves are given. They are stated to be based on test data, and located in what seems a logical relation to each other. Their shape very closely approaches Johnson's parabolas, but for the higher yield strengths they become tangent to the bending-stress curve above half that yield.

In Fig. 6 are shown the relations established by the engineering staff of the Mannesmannrohren Werke at Dusseldorf, as determined by the equation:

$$P = S_y\left(\frac{2.706}{\frac{D}{t}} - 0.043\right)$$

published in 1938. This was called to the writer's attention by J. J. Dunn. Mr. Dunn himself introduced and used in the report of manufacturers' subcommittee 5-A (Fig. 7) the following similar relation:

$$P = S_y\left(\frac{2.447}{\frac{D}{t}} - 0.04494\right)$$

He uses this between the intersection of the "elastic" curve and $D/t = 14$, but below he uses Lame's formula in the form:

$$P = \frac{2S_y\left(\frac{D}{t}-1\right)}{\left(\frac{D}{t}\right)^2}$$

It has been said of all of these procedures that Johnson's parabolas, or any other of these devices, are purely arbitrary selections. Their justification is that they are simple curves to compute; they seem to fit the test results reasonably well; and, as we have no rational relation, they are as good as any. You will agree that these are not very substantial grounds for such an important relation. In these empirical relations, determined by tests and depending on methods of least squares or, in some cases, just plain judgment of the curve-drawer's eye for their location, we find the implication that the stress at collapse approaches the yield stress when $D/t$ equals 2. But at higher values of $D/t$ it is possible to deform permanently (i.e., collapse) the tube without reaching the yield point, or even the proportional limit in most cases. This concept follows

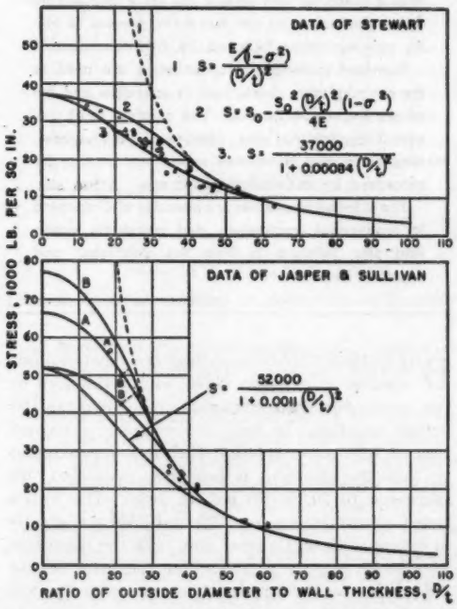

DATA OF STEWART
1 S = E/(1-σ²)/(D/t)²
2 S = Sy - Sy²(D/t)²(1-σ²)/4E
3. S = 37000/1+0.00084(D/t)²
DATA OF JASPER & SULLIVAN
S = 52000/1+0.0011(D/t)²
STRESS, 1000 LB. PER SQ. IN.
RATIO OF OUTSIDE DIAMETER TO WALL THICKNESS, D/t

*Fig. 4—Bending-stress-formula curves*

*(Continued on Page 214)*

# High-Octane Aviation Fuel by the Sulfuric-Acid Alkylation Process


## ABSTRACT

**Aviation fuels with octane ratings approaching 100, or above, are increased greatly in commercial availability by the introduction of the sulfuric-acid alkylation process.**

**This process affects directly the union of isoparaffins with olefins in approximately equal volumes to form branched-chain paraffins in the presence of strong commercial sulfuric acid as the catalyst, and in a single-stage operation.**

**A new source of high-octane gasoline is available; and, with sufficient isoparaffin, potential yields of branched-chain product by alkylation from a given refinery stream are more than double those obtainable by the two-stage process of olefin polymerization followed by hydrogenation.**

**Standard materials of construction are used in the six alkylation plants now in operation and the others under construction. The catalyst is of universal availability; and, after use in the process, may be reused in treating operations, or may be recovered by conventional methods.**

**The alkylation process is unusually well adapted to commercial application, and marks an important step forward in both the petroleum and aviation fields.**



A Contribution By

**ANGLO-IRANIAN OIL CO. LTD., HUMBLE OIL & REFINING CO., SHELL DEVELOPMENT CO., STANDARD OIL DEVELOPMENT CO., AND TEXAS CO.**



**A.P.I.** — **Presented before annual meeting, Chicago, Ill., November 13-17, 1939**


BRANCHED-CHAIN paraffins are outstandingly valuable as aviation fuels,[1] as is evidenced by the increase in their consumption for making 100-octane gasoline. In 1937 the domestic consumption of 100-octane aviation fuel was approximately 7,000,000 gal., and it has been estimated this increased to 20,000,000 gal. in 1938.[2] The anticipated consumptions for 1939 and 1940 are greatly in excess of these figures; and, with the assurance of a larger supply of 100-octane fuel at a reasonable price, a further increase undoubtedly will result from changes in airplane-motor design to take advantage of the better performance and economy possible when operating with such a gasoline.

The normally gaseous hydrocarbons such as $C_3$ and $C_4$, because of their high volatility, find only a limited use in gasoline; but they are capable of being transformed into high-octane fuels of very great value. Processes in which the lower olefins from cracking operations first are polymerized and then hydrogenated are in successful operation already, and have been described in the literature.[3] Another method of utilizing the light hydrocarbons exists in which the paraffin is combined directly with the olefin to produce a saturated fuel, thus avoiding the two stages of polymerization and hydrogenation. Previous investigations have shown that metallic halides, such as aluminum chloride and boron trifluoride, catalyze the reaction of isoparaffins with olefins. This coupling reaction usually is designated as an alkylation reaction. However, alkylation using metallic halides as catalysts as yet has not been developed to a commercial process.

Recently it has been shown that sulfuric acid is a catalyst for the reaction. The rapid development of the commercial process has depended upon the use of this catalyst, as it provides a cheap material which can be handled in standard engineering equipment under conditions similar to those existing in proven processes. The products obtained have a high octane number, and possess the other characteristics necessary for superior aviation fuels.

The present sulfuric-acid process represents the combined efforts of the Anglo-Iranian, Humble Oil, Shell Development, Standard Oil Development, and Texas research staffs. These groups, working independently, had developed processes which, though somewhat different in details of operation and in the results obtained, were in principle essentially similar. In the best interest of the petroleum industry as a whole, and in order that a major new source of high-octane aviation fuel should be made available for national defense without delay or waste of correlative experience, their efforts recently have been combined to expedite the commercial application of the process.

It is not the intention of the present paper to review in detail the theory of the alkylation reaction nor its possible widespread application in organic chemistry. Data of this type have been reported already at recent scientific meetings[4] and in the literature.[5] Rather, it is intended to outline briefly the underlying principles; and then discuss the type of equipment used, the conditions of operation, and the results which can be obtained when operating with various representative feed stocks.

### Principles of Operation

When aliphatic olefins are mixed with strong sulfuric acid at around atmospheric temperatures, the primary reaction is one of olefin absorption in the acid to form alkyl sulfates. This absorption is a relatively rapid exothermic reaction. Saturated normal hydrocarbons remain virtually unabsorbed, but isoparaffins such as isobutane are absorbed to a slight extent if the sulfuric acid is at a concentration of 90 per cent or higher. It has been estimated that the rate of absorption of the olefins is about 700 times faster than that of the isoparaffins.

Although it is not necessary for our purpose to assume a particular reaction mechanism, it is helpful to visualize that the coupling reaction occurs in the acid phase through the formation of an olefin acid ester, which then reacts with the isobutane. In simple form, the reaction would consist of the following two steps:

**Absorption Step**

$$\underset{\text{Butylene}-1}{CH_3CH_2CH=CH_2} + \underset{+\text{Acid}}{H_2SO_4} \rightarrow \underset{\rightarrow\text{Alkyl ester}}{CH_3CH_2CH(HSO_4)CH_3}$$

**Coupling Step**

$$\underset{\text{Alkyl ester}}{CH_3CH_2CH(HSO_4)CH_3} + \underset{+\text{Isobutane}}{(CH_3)_2CH-CH_3} \rightarrow \underset{\rightarrow\text{Octane}}{CH_3CH_2CH(CH_3)-C(CH_3)_2-CH_3} + \underset{+\text{Acid}}{H_2SO_4}$$

Actually, the reaction is considerably more complicated, as the product first formed tends to undergo splitting and rearrangement. Other explanations involving, for example, assumptions of hydrogen-ion exchange are also capable of accounting for the reactions which occur; but it is not our intention to discuss these points at this time —which, in any case, have little bearing on process operations.

In order to prevent the absorption step from proceeding to a point where the acid becomes useless for coupling, it is desirable to have present in the reaction zone a vast excess of isoparaffin. In batch studies, this mass effect of the isoparaffin is achieved by adding slowly the olefin to an emulsion of the isoparaffin and sulfuric acid.

When the rate of addition is kept sufficiently slow to prevent any accumulation of unreacted olefin in the reactor, a completely saturated product is obtained. However, much faster overall reaction rates and better control of the reaction can be obtained by continuous operation.

In continuous operation, the suppression of the extent of olefin absorption is achieved first by diluting the olefin feed with isoparaffins, and then adding this mixture to an emulsion of acid and reacted hydrocarbon which is rich in isoparaffins, but substantially olefin-free. In commercial plants the requisite mixture is obtained by the use of a circulating pump and additional reaction space in which intimate contact is maintained by the velocity of flow through baffles or jets. A simplified flow diagram of a commercial plant is given in Fig. 1.

Modifications of these single-stage reactors, of course, are possible, and in certain instances may lead to improved results. Additional reactors may be arranged in parallel or in series, and the feed may be split between the reactors.

Sulfuric acid is the only chemical agent used, although a caustic wash of the product usually is

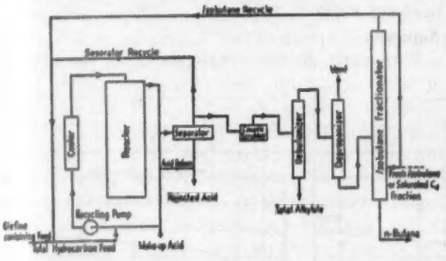



*Fig. 1—Flow diagram—sulfuric-acid alkylation plant*

provided to neutralize any traces of acid which might be carried over from the separator to the fractionation system. In commercial operation a portion of the acid continuously is withdrawn from the separator, and replaced by makeup acid of 96 to 100 per cent strength. This replacement is essential if the quality of the product is to be maintained, as otherwise side reactions gradually would weaken the acid to a point where it no longer efficiently could catalyze the alkylation reaction. The acid usually is withdrawn at from 88 to 90 per cent titratable acidity, but other ranges in certain instances may apply — depending on the feed stocks being processed and the quality of product desired. The drop in acidity from 98 to 90 per cent, or lower, is due largely to the absorption of hydrocarbons in the acid—although contamination by products from oxidation and other side reactions are contributing factors. This dilution effect is by no means equivalent to water dilution, because 90 per cent sulfuric acid, in which water makes up the other 10 per cent, is entirely unsuitable for alkylation.

The amount of acid added usually is referred to as acid replacement, and is a major factor in determining the efficiency of operation. The quantity added is affected both by the composition of the feed stocks and by the operating conditions used. Strictly speaking, the acid is not consumed in the chemical sense, but merely is diluted by the hydrocarbon. A major part of the acid can be recovered by conventional reconcentration methods, or it can be used for acid treating elsewhere in the refinery.

## Feed Stocks

Alkylation can be carried out with a wide variety of olefins and isoparaffins, but for all practical purposes olefins from $C_3$-$C_5$, inclusive; and the isoparaffins, isobutane and isopentane, are those used. Ethylene-containing feed stocks may be used, but the reaction is accompanied by an increased acid consumption. Olefins above $C_5$ yield products boiling largely above the aviation-gasoline range. However, it has been found that some $C_6$ and $C_7$ polymers containing eight or more carbon atoms prepared by catalytic process and some other olefins of branched structure rearrange on alkylation to yield products boiling below those expected, and predominantly in the gasoline range.[4]

Isobutane is the most widely used isoparaffin; because, on account of its high volatility, it has a restricted direct use in gasoline. When coupled with olefins, it leads to products having a highly branched structure. Isopentane and isohexane are in themselves valuable constituents of gasoline, and would be used only in the alkylation process if large quantities were available over and above those required to meet volatility requirements.

Isobutane is alkylated readily by most of the pure olefins, and with a low catalyst consumption. Unfortunately, in the refinery the olefins are present in mixtures along with dienes, aromatics, mercaptans, thiophenes, and other substances. These may affect markedly the yield and acid consumption; as in the laboratory it has been shown that mercaptans, amines, dienes, aromatics, and oxygenated compounds are absorbed by the acid, and reduce its activity rapidly. The cost of pretreating the feed to remove these impurities must be weighed against the resulting economy in acid. For example, the oxidation of the sulfur compounds causes an increase in consumption of acid, but does not affect directly the quality of the product. A simple caustic wash, therefore, usually is warranted. Amines, if present, can be removed by water washing. Dienes,* aromatics, and oxygenated compounds, however, are more difficult to remove; and it is doubtful if a pretreatment process is justified. Entrained water is removed by settling, but the quantity of dissolved water present hardly justifies much expense in predrying the feed. Thus, each feed stock constitutes a separate problem depending on the amount and type of impurity present, and may require adjustment of the operating conditions over and above the adjustments necessary when operating with different pure olefins. It is not possible within the scope of the present paper to outline in detail the consequences of the various impurities or to give the effect of varying the operating conditions with each olefin feed stock. However, a general discussion of the trends affected by changes in operating conditions, and results which may be expected under suitable conditions for a few representative feed stocks, will indicate the characteristics of the alkylation process.

## Effect of the Operating Variables

In view of the fact that the actual concentration of olefin in the reaction zone is so low that under practical operating conditions it cannot be measured, it is necessary to consider the alkylation reaction from a study of the variables enumerated below:

Isoparaffin-olefin ratio.
Contact time.
Acid strength.
Temperature.
Acid-hydrocarbon ratio.
Olefin concentration of the feed.
Agitation.

In consideration of the effects of these variables it should be kept in mind that they are all interdependent and that, fortunately, factors which increase the acid life also improve the yield and quality of products.

*Butadiene will alkylate to give principally octanes, but the acid consumption is high.

### Isoparaffin-olefin ratio.

The isoparaffin-olefin mole ratio in the hydrocarbon feed stock prior to contact with acid is an extremely important variable, and has a marked influence on the acid life and on the yield and quality of product. In accordance with the concept of mass action, the higher the ratio the better the results obtained. This is shown in the case of an isobutane-$C_4$ olefin feed in Fig. 2; the other operating conditions were constant for this series of experiments. It will be seen that there is a marked increase in the total yield, per cent of aviation fraction, and octane number of the product, and a corresponding decrease in the acid consumption, as the isoparaffin-olefin ratio is increased from 2:1 to 5:1. A 5:1 ratio, therefore, usually is chosen as the lowest ratio for commercial operation with $C_4$ olefins. A similar effect is noted with other olefinic feed stocks. With $C_3$ and

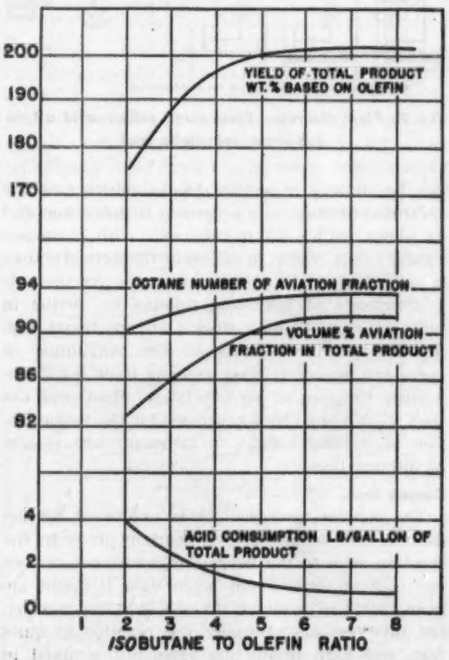



*Fig. 2—Effect of isobutane to olefin ratio for $C_4$ olefins*

the higher olefins which appear to be somewhat less reactive, ratios greater than 5:1 normally are used.

These high ratios are obtained by blending the olefin feed and the required makeup isobutane with isobutane recovered from the fractionation system. Alternatively, in order to reduce the fractionation load, the hydrocarbon phase which is rich in isoparaffin may be recycled from the top of the separator to meet the feed prior to its contact with the acid—thus increasing an original isobutane-olefin ratio of less than 5:1 to 5:1 or greater.

Another alternative is to use several stages in series, and split the olefin feed between the stages. This is done by adding the olefin to the hydrocarbon phase from each separator before it enters the succeeding stage. A simplified flow diagram showing this variation is given in Fig. 3. It will be seen that in a large commercial plant where several parallel reactors are already available, this splitting of the olefin feed very easily is carried out by relatively minor piping changes, and many of the plants now under construction have provisions for both separator recycle and split-olefin feed.

However, neither of these two alternatives is equivalent to returning the same amount of pure isobutane, as it has been found that side reactions are enhanced by the higher concentration of prod-

uct and its prolonged contact in the reaction zone. These alternatives do give a substantial reduction in the amount of isobutane recycle; and provide a means for further improving the yield, acid life, and quality of product in a system which already has a relatively high isobutane-olefin ratio obtained in the normal manner.

Although the ratio of isobutane to olefin in the feed to the reactor is very high, the actual consumption of isobutane is about theoretical (i.e., one mole of isoparaffin to one mole of olefin), and

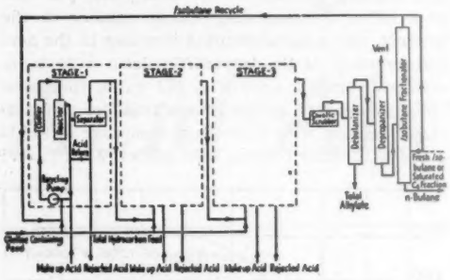



*Fig. 3—Flow diagram—Three-stage sulfuric-acid alkylation plant, split-olefin feed*

can be slightly in excess due to splitting of the saturated product to a saturated hydrocarbon and an olefin, which latter can react with more isobutane; thus, yields in excess of theoretical actually are obtained in certain instances. As there is a deficiency of isobutane relative to olefins in most refinery $C_4$ feed stocks, an additional supply of isobutane is required. The availability of isobutane, therefore, becomes the basis for determining the size of an alkylation plant and the feed stock to be used; processes for the isomerization of normal butane to isobutane are clearly of interest here.

**Contact time.**

The contact time usually is expressed by the ratio of the volume of hydrocarbon phase in the reaction zone to the volume of hydrocarbon feed per unit of time. From batch data it might appear that long contact times would be required for this reaction. Actually the reaction is quite fast, and high production rates are attained in the reaction systems developed. Contact times as low as 5 minutes have been used with $C_4$ fractions, although 20 minutes to 40 minutes have been allowed in the design of commercial plants. It is difficult to give an optimum contact time for all feed stocks. With butylene feed stocks, the effect of reducing the contact time to less than 5 minutes is to reduce the quality of the product, and increase the concentration of olefin absorbed in the acid. With some other feed stocks, this effect is more pronounced at longer contact times.

**Acid strength.**

The acid strength is an extremely important variable, and there is a great difference between the makeup-acid strength and the actual acid strength in the reactor. It has been found that the practical makeup-acid strength lies between 96 and 100 per cent acid. Lower acid strengths are somewhat more effective at higher temperatures, whereas 98 to 100 per cent acids are best below 70° F. The acid strength in the reactor proper is lower than the makeup-acid strength due to the accumulation of hydrocarbons and some water which is introduced in the feed stock, or is derived from side reactions such as oxidation of the products. Under usual operating conditions, the acid in the reactor has a titratable acidity of 88 to 90 per cent, and is maintained at this strength by the addition of makeup acid.

**Temperature.**

The effect of temperature closely is associated with acid strength, and differs with different olefin feed stocks. Makeup acid of 98 to 100 per cent strength, when used much above 70° F., leads to increasing oxidation of the hydrocarbons—which results in increased acid replacement, and decreased yield and quality of products. With $C_4$ olefins, lower temperatures appear to favor catalyst life, and the optimum temperature in this case lies between 32° and 50° F.

**Acid-hydrocarbon ratio.**

The volume ratio of acid to hydrocarbon in the reaction zone is also important. For most purposes, this is about 1:1; but in specific instances it may be as high as 2:1. Variations within this range are not critical, but higher or lower ratios give poorer results.

**Olefin concentration of the feed.**

The effect of olefin concentration in the total hydrocarbon feed is of secondary importance, provided the isobutane-olefin ratio is maintained. In order to reduce equipment sizes and the acid consumption as much as possible, it is desirable to have the olefin concentration reasonably high. With average $C_4$ fractions from cracked gasoline as the olefin feed stocks, and with a 5:1 isobutane-olefin ratio, the olefin concentration will vary from about 8 to 14 per cent, and in this range about equal results are to be expected. The normal paraffin present does not enter into the alkylation reaction; but if present to a large extent, may require a small increase in the isoparaffin-to-olefin ratio.

**Agitation.**

Very early in the development of the process it was found that excellent agitation was essential for good results. In experiments in which poor dispersion was used, low yields of product resulted, and the acid consumption was high. Many means for obtaining a good dispersion were studied. These included various mechanically driven mixers, packed towers, and combinations of pumps with jets or baffles. However, it soon was found that intimate contact best was obtained by means of a pump-recycling-acid-hydrocarbon emulsion through a system of jets or baffles. This method, therefore, has been adopted uniformly for commercial installations.

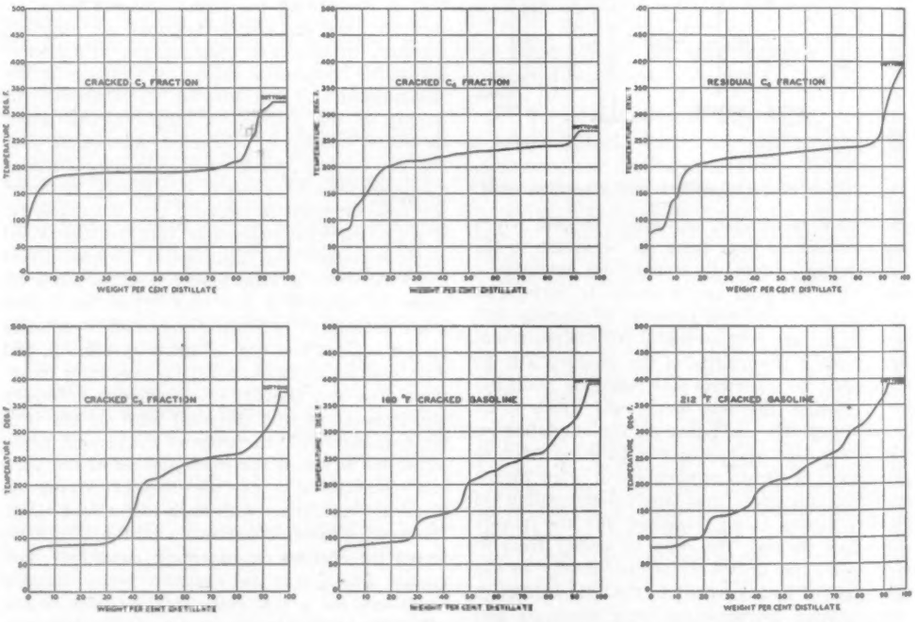



*Fig. 4—True-boiling-point distillation of total alkylate from isobutane and representative olefin feed stocks*

**TABLE 1—ALKYLATION WITH REPRESENTATIVE REFINERY OLEFIN FEED STOCKS**

| Olefin feed stock (per cent by weight of olefin)— | $C_3$ fraction from cracking *30 | $C_4$ fraction from cracking †48 | Residual $C_4$ fraction from isooctane manufacture ‡24 | $C_5$ fraction from cracking 55 | 70-160°F. end point cracked gasoline 52 | 70-210°F. end point cracked gasoline 50 |
|---|---|---|---|---|---|---|
| Conditions: | | | | | | |
| Isoparaffin used | Isobutane | Isobutane | Isobutane | Isobutane | Isobutane | Isobutane |
| Mole ratio of isoparaffin to olefin | 8 | 5 | 5 | 8 | 8 | 8 |
| Makeup acid strength, per cent by weight of sulfuric acid | 98-100 | 98-100 | 98-100 | 98-100 | 98-100 | 98-100 |
| Volume ratio of acid to hydrocarbon ratio | 1 | 1 | 1 | 1 | 1 | 1 |
| Temperature, °F. | 85 | 32-50 | 32-50 | 50 | 50 | 50 |
| Contact time, minutes | 20-40 | 20-40 | 20-40 | 20-40 | 20-40 | 20-40 |
| Titratable acidity of rejected acid, as per cent by weight of sulfur acid | 88-90 | 88-90 | 88-90 | 88-90 | 88-90 | 88-90 |
| Per cent by weight of yield of total alkylate based on olefin in feed | 185 | 190-200 | 200-215 | §134 | §126 | §115 |
| Per cent by volume of total alkylate based on olefin in feed | 138 | 158-166 | 168-180 | §125 | §119 | §113 |
| Aviation fraction (end point, 300° F.) in total alkylate, per cent | 92-95 | 88-90 | 89-91 | 90 | 85 | 77 |
| Makeup acid, lb. per gal. of total alkylate | 2.6 | 1 | <1 | 1.5 | 1.7 | 3.3 |

*With mixed $C_3$ and $C_4$ fractions, materially better results are obtained.
†About 18 per cent isobutylene present.
‡Largely butylene-2.
§Yield based on total refinery fraction, which includes saturates.

## Characteristics of Products

The products are particularly suitable as aviation fuels because of their isoparaffinic nature, high octane number, high lead susceptibility, very low sulfur content, high calorific value, and lack of sensitivity to different engine conditions.

With the exception of the alkylation product from a gasoline of 210° F. end point, products of

isobutane and the lower olefins boil almost entirely in the gasoline range; from 85 to 90 per cent boils below 300° F. Thus they are an excellent source of blending materials for aviation gasolines.

It has been pointed out that, although the alkylation reaction can be applied to a wide variety of olefin feeds, the conditions of operation for these feeds may differ. This is particularly true of the cracked-gasoline fractions containing $C_3$ hydrocarbons, or higher, in which the types of impurities and the composition and ratio of hydrocarbons are more likely to vary with the crude and the method of refining. In Table 1 a few representative feed stocks have been selected, and the operating conditions and yields to be expected are given. Representative precision-distillation curves of the resulting products are shown in Figure 4. It will be seen that for the $C_4$ olefins the yields obtained are very close to theoretical. For the higher olefins from cracked-naphtha fractions, the yields are apparently less; this is due largely to the absorption of aromatics, dienes, or other similar components in the acid phase; and if these losses are deducted, excellent yields are obtained also on the higher olefins, and the products are fully saturated. The products formed are not entirely those expected from the straight coupling of the isoparaffin with the olefin. This is shown in the case of the alkylation of $C_4$ fractions, in which small isopentane and hexane plateaus are found in the distillation curve of the products (Fig. 4)—indicating the presence of $C_3$ and $C_5$ hydrocarbons in greater amount than could have been introduced with the feed.

The operating conditions given in Table 1 are typical for these feed stocks. However, they do not represent necessarily the best results which have been obtained. It will be noted that higher isobutane-olefin ratios are used with propylene and the higher olefins than are used with $C_4$ olefins. This is done to reduce the acid consumption. The contact times are similar, and the strength of the rejected acid is the same. The acid consumption varies with the feed used, and is the highest in the case of gasoline with an end point of 210° F. Cracked $C_3$ fraction, free of butylene, also shows a high acid consumption.

The A.S.T.M. distillation and other data pertinent to the evaluation of these products for aviation fuels are given in Table 2. It will be seen that both the total product of the reaction and the aviation fraction derived from it are substantially sulfur free and saturated. Even when cracked gasolines of high sulfur content are used as feed stocks the product is sulfur free, but the catalyst consumption is increased by the presence of the sulfur. Samples of alkylation products have been exposed to strong sunlight for months without recognizable discoloration or gum formation.

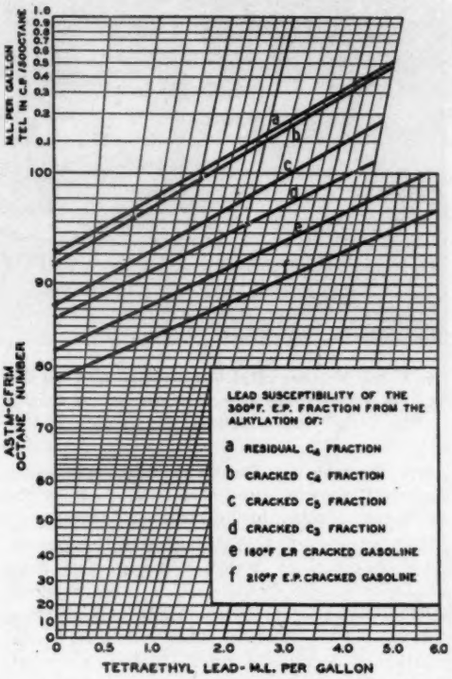

M.L. PER GALLON TEL IN C.P. ISOOCTANE
ASTM-CFRM OCTANE NUMBER
TETRAETHYL LEAD - M.L. PER GALLON
LEAD SUSCEPTIBILITY OF THE 300°F. E.P. FRACTION FROM THE ALKYLATION OF:
a RESIDUAL C4 FRACTION
b CRACKED C4 FRACTION
c CRACKED C3 FRACTION
d CRACKED C5 FRACTION
e 160°F E.P. CRACKED GASOLINE
f 210°F E.P. CRACKED GASOLINE

*Fig. 5—Lead susceptibility of the 300° F. end-point fraction from alkylation*

Data showing the clear A.S.T.M.-C.F.R. octane number and the lead susceptibility of the various products are given in Fig. 5. For comparison, the lead susceptibility of an untreated gasoline with an end point of 160° F. and one with an end point of 210° F. is shown in Fig. 6. It will be seen that these gasoline fractions after alkylation have such a greatly improved lead susceptibility that it is possible to produce 95-octane gasoline with moderate amounts of lead.

All of the alkylation products given in Table 2 are excellent blending stocks for 100-octane aviation fuels. It is not within the scope of this paper to discuss the wide number of possible blends. Their composition may vary widely, depending on the base stock used and the alkylate chosen; but sufficient data already have been presented to allow those familiar with the art to prepare blends suitable to their own refinery conditions. For illustrative purposes, one such blend prepared from 50 per cent of $C_4$ aviation alkylate and 50 per cent of 77-octane straightrun gasoline base stock is given in Table 3. Similar blends may vary over the range of 40 to 70 per cent of aviation alkylate, depending on the properties of the stocks.

**TABLE 3—CHARACTERISTICS OF 100-OCTANE AVIATION GASOLINE**

| | |
|---|---|
| Gravity, °A.P.I. | 71.8 |
| Octane No., clear (A.S.T.M.-C.F.R.) | 85 |
| Octane No. plus 3 ml. tetraethyl lead (Army) | 100 |
| Copper-dish gum, mg. per 100 ml. | 1 |
| Acid heat, °F. | 2 |
| Freezing point, °F. | Below −76 |
| Reid vapor pressure, lb. per sq. in. | 7 |
| 50 per cent point, °F. | 207 |
| End point, °F. | 308 |

A large percentage of the alkylation products can be prepared to meet the volatility requirements of aviation fuels, without blending. Therefore, when there is a demand for fuels having antiknock properties superior to unleaded isooctane, these super fuels can be made from selected alkylation fractions by leading.

The alkylation products boiling above the normal aviation range also have high octane values and good lead susceptibilities, and thus ideally are suited for use when, in addition to these desirable properties, low volatility is required.

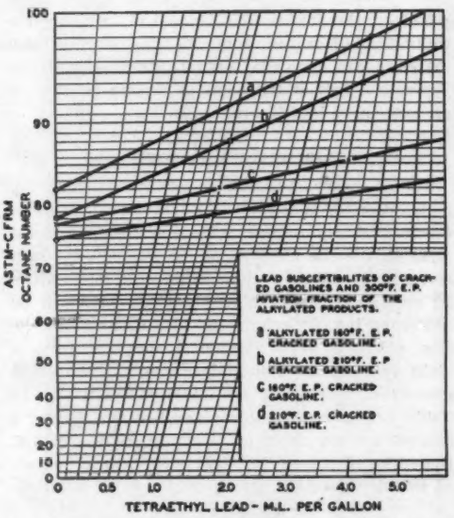

ASTM-CFRM OCTANE NUMBER
TETRAETHYL LEAD - M.L. PER GALLON
LEAD SUSCEPTIBILITIES OF CRACKED GASOLINES AND 300°F. E.P. AVIATION FRACTION OF THE ALKYLATED PRODUCTS.
a ALKYLATED 160°F. E.P. CRACKED GASOLINE.
b ALKYLATED 210°F. E.P. CRACKED GASOLINE.
c 160°F. E.P. CRACKED GASOLINE.
d 210°F. E.P. CRACKED GASOLINE.

*Fig. 6—Lead susceptibility of cracked gasolines and 300° F. end-point aviation fraction of the alkylated products*

**TABLE 2—PROPERTIES OF PRODUCTS FROM ALKYLATION WITH REPRESENTATIVE REFINERY OLEFIN FEED STOCKS**

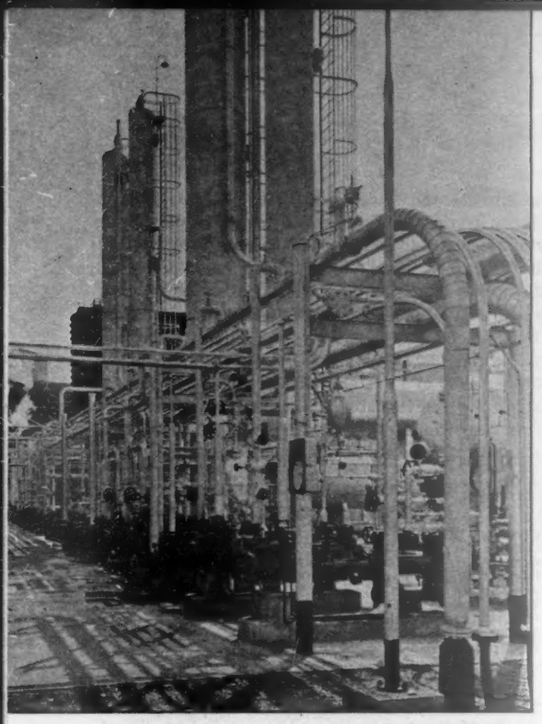
| Olefin feed stock | $C_3$ fraction from cracking | $C_4$ fraction from cracking | Residual $C_4$ fraction from isooctane manufacture | $C_5$ fraction from cracking | 70-160°F. end point cracked gasoline | 70-210°F. end point cracked gasoline |
|---|---|---|---|---|---|---|
| Isoparaffin used | Isobutane | Isobutane | Isobutane | Isobutane* | Isobutane* | Isobutane* |
| Properties of total alkylate ($C_5$-free): | | | | | | |
| Gravity, °A.P.I. | 72.1 | 69.2 | 69.2 | 76.6 | 72.1 | 70.6 |
| Bromine No., g. of bromine per 100 ml. | 0.1-0.4 | 0.3-0.5 | 0.3-0.5 | 0.5-1.0 | 0.5-1.0 | 1-2 |
| Sulfur, per cent | 0.001 | <0.001 | <0.001 | <0.005 | <0.005 | <0.005 |
| Reid vapor pressure, lb. per sq. in. | 4 | ..... | 3 | 8 | ..... | ..... |
| Octane No. (A.S.T.M.-C.F.R.) | 88.0 | 91.5 | 92.5 | 87.0 | 83.0 | 79.0 |
| A.S.T.M. distillation, in °F.: | | | | | | |
| Initial boiling point | 152 | 120 | 117 | 108 | 126 | 128 |
| End point | 387 | 403 | 378 | 446 | 455 | 414 |
| 10 per cent point | 180 | 182 | 183 | 144 | 158 | 162 |
| 20 per cent point | 185 | 199 | 203 | 164 | 169 | 176 |
| 30 per cent point | 189 | 209 | 213 | 191 | 183 | 190 |
| 40 per cent point | 192 | 217 | 221 | 222 | 201 | 208 |
| 50 per cent point | 194 | 222 | 225 | 242 | 220 | 220 |
| 60 per cent point | 198 | 230 | 228 | 253 | 236 | 236 |
| 70 per cent point | 202 | 235 | 231 | 261 | 250 | 248 |
| 80 per cent point | 212 | 242 | 236 | 277 | 270 | 266 |
| 90 per cent point | 271 | 267 | 250 | 306 | 316 | 328 |
| 95 per cent point | 345 | 340 | 314 | 368 | 374 | 385 |
| Recovery, per cent | 98 | 99 | 98.5 | 99 | 98 | 98 |
| Recovered at 266° F., per cent | 88 | 89.5 | 92 | 79 | 76 | 70 |
| Properties of 300° F.-end point fraction: | | | | | | |
| Unsaturation, per cent | Negligible | Negligible | Negligible | Negligible | Negligible | Negligible |
| Sulfur, per cent | Negligible | Negligible | Negligible | Negligible | Negligible | Negligible |
| 50 per cent point, °F. | 190 | 220 | 221 | 209 | 200 | 205 |
| Reid vapor pressure, lb. per sq. in. | ..... | 3.5 | 3.0 | 9.0 | 11.6 | 7.4 |
| Octane No. (A.S.T.M.-C.F.R.) | 89 | 92 | 93 | 87 | 82 | 78 |

*Products not depentanized

## Acid Requirements

It will be seen in Table 1 that the acid consumption differs for various feed stocks, and is least for the case in which isobutane is alkylated with $C_4$ olefins. However, as has been pointed out already, the acid is not consumed in the chemical sense, but merely has been diluted by absorbed hydrocarbons and water. It usually is withdrawn from the reactor at a titratable acidity of about 88 to 90 per cent, and in this form it can be used elsewhere in the refinery for acid treating naphthas or light fuel oils. It has been found that, on the basis of the sulfuric-acid content, the rejected acid from alkylation is equivalent to fresh acid for gum reduction, but is not quite as efficient as fresh acid for sulfur reduction.

In many cases the acid-treating requirements of a refinery are sufficient to utilize all of the rejected alkylation acid. However, when an ex-



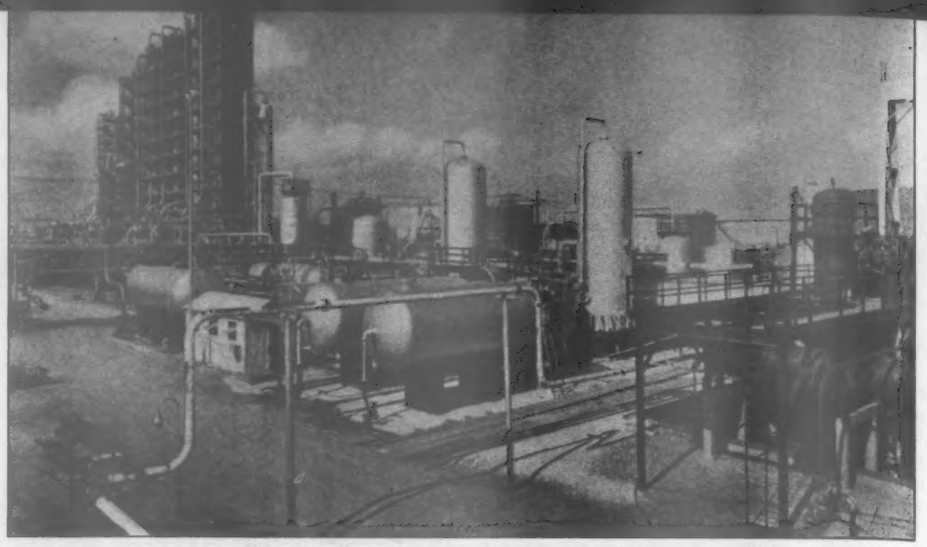


*Fig. 7, left: Martinez alkylation plant of Shell Oil Co., Inc. Fig. 9, above: Baytown alkylation plant of Humble Oil & Refining Co.*

cess of acid exists, it is possible to recover and reconcentrate it for further use in alkylation. This usually is done first by diluting the acid to about 50 per cent to release the dissolved oil. This amounts to about 6 to 8 per cent of the used acid and, on dilution, it separates as an upper layer which can be drawn off. The acid is then substantially free of organic material, and conventional methods can be used for reconcentration. Thus the actual cost of the catalyst can be reduced to an extremely low figure.

## Commercial Aspects

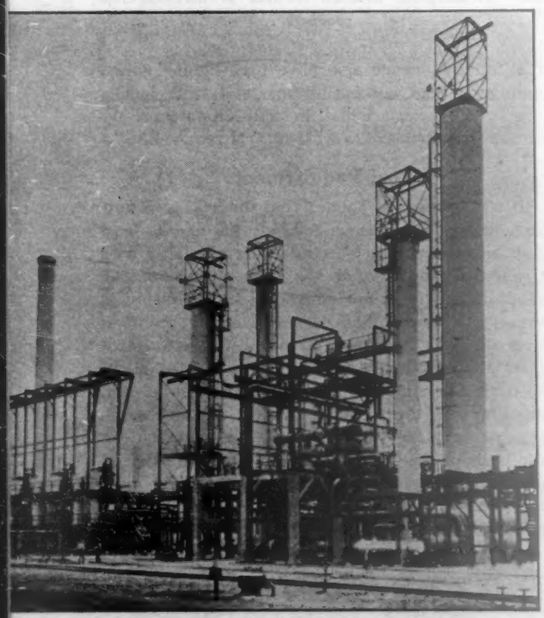
One of the basic factors to be considered in the installation of a commercial alkylation plant is the availability of the isoparaffin, and in most cases this is the factor limiting the capacity of a given plant. With a given supply of isoparaffin, an approximately equal amount of olefin can be converted by alkylation; and on this basis alkylation offers a very distinct advantage, from a yield and process standpoint, over the two-stage process of polymerization and hydrogenation. In Table 4 a comparison is given for the different processes when using a $C_4$ fraction from cracking. It will be seen that the yield of 87-octane unleaded aviation gasoline is markedly greater by alkylation. The table also illustrates the great advance made in the manufacture of aviation fuels by the petroleum industry during the past 5 years.

With other olefin feed stocks, alkylation is even more advantageous. Whereas the alkylate from propylene has an octane number of 88, catalytic polymerization of propylene leads to a polymer of relatively low octane number which, on hydrogenation, is degraded further. Catalytic polymerization of $C_5$ or higher olefins is not commercial.

The sulfuric-acid alkylation process is basically a new development. However, the equipment employed is of standard type, and its practicability is demonstrated amply by the fact that similar equipment has been used for the manufacture of isooctanes by the hot-acid and cold-acid processes for nearly 5 years without any major replacements being necessary. Also, as the sulfuric acid used as the alkylation catalyst is of high concentration and the plants are operated at below atmospheric temperature, corrosion is negligible—and steel equipment can be used throughout. The auxiliary fractionating equipment is of standard type, and presents no difficulties in design and construction. Thus no new nor very troublesome engineering principles are encountered, and competent engineering service is available for construction of plants. Individual requirements vary widely, and require study to determine the particular conditions to be used in each case.

Alkylation is a commercially proven process. The development has been extremely rapid, due to cooperative effort; and at present there are six commercial plants in operation, and a number of plants under construction. A list of these plants, together with their rated capacities, is given in Table 5. Photographs of several of the plants now in operation are given in Figs. 7, 8, and 9. The results from the commercial plants are fully up to expectation.

*Fig. 8: Port Arthur alkylation plant of the Texas Co.*



## Conclusion

As the result of the combined efforts of the research staffs of five major oil companies, the alkylation process has been developed to proven commercial success; and it has been found to be suited ideally to the manufacture of high-octane fuels. Several commercial plants are being operated or in the process of construction, and a new method of gasoline manufacture has been achieved which undoubtedly will affect the petroleum industry as a whole, and contribute greatly to aviation progress.

**TABLE 5—ALKYLATION PLANTS IN OPERATION AND UNDER CONSTRUCTION**

| Company and location— | Aviation alkylate (bbl./day) |
|---|---|
| **Operating** | |
| Humble Oil & Ref. Co., Baytown, Tex. | 1,200 |
| Shell Oil Co., Inc., Dominguez, Calif. | 800 |
| The Texas Co., Port Arthur, Tex. | 750 |
| Shell Oil Co., Inc., Martinez, Calif. | 500 |
| Standard Oil Co. of New Jersey, Bayway, N.J. | 175 |
| Anglo-Iranian Oil Co., Abadan, Iran | 100 |
| **Under Construction or Consideration** | |
| Humble Oil & Ref. Co., Baytown, Tex. | 1,500 |
| Lago Oil & Transport Co., Aruba, N.W.I. | 520 |
| Magnolia Petroleum Co., Beaumont, Tex. | 2,140 |
| N.K.P.M., Palembang, Sumatra | 560 |
| Shell Oil Co., Inc., Houston, Tex. | 1,500 |
| Shell Oil Co., Inc., Wood River, Ill. | 1,500 |
| Standard Oil Co. of Louisiana, Baton Rouge, La. | 1,200 |
| Union Oil Co. of California, Wilmington, Calif. | 270 |

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**TABLE 4—COMPARISON OF ALKYLATION AND POLYMERIZATION FOR $C_4$ FRACTION FROM CRACKING**

(Basis, 1 gal. of feed)

| Feed composition, per cent by volume: | |
|---|---|
| Propane | 1 |
| Isobutylene | 18 |
| *n*-Butylenes | 30 |
| Isobutane | ¶9 |
| *n*-Butane | 42 |
| Total | 100 |

| Method used— | Cold-acid absorption and polymerization plus hydrogenation | Catalytic polymerization plus hydrogenation* | Catalytic high-pressure polymerization plus hydrogenation† | Alkylation |
|---|---|---|---|---|
| Additional isobutane, gal. per gallon of feed | Nil | Nil | Nil | 0.42 |
| Product‡ boiling below 300° F., gal. | 0.11 | 0.25 | 0.32 | 0.73 |
| Octane No. of saturated aviation cut (A.S.T.M.-C.F.R.) | 99-100 | 96-98 | 91-93 | 92-94 |
| Gallons of 87-octane fuel per gallon of feed prepared by blending aviation cut with 72-octane base stock§ | 0.21 | 0.42 | 0.43 | 1.02 |

*Either UOP or hot-acid process operating for maximum octane number.
†Operating for maximum yield.
‡Data are approximate. The yield depends somewhat on operating conditions.
§Assuming straight-line function and motor-method octane numbers.
¶In general, refinery streams are richer in isobutane.

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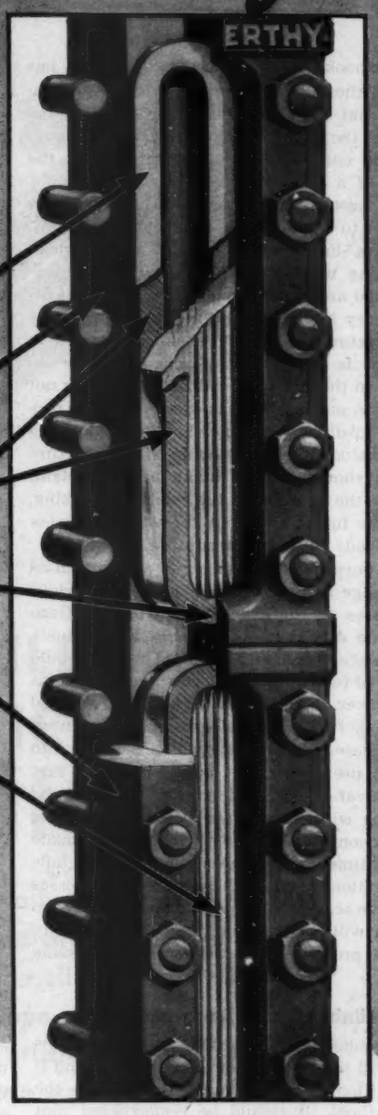


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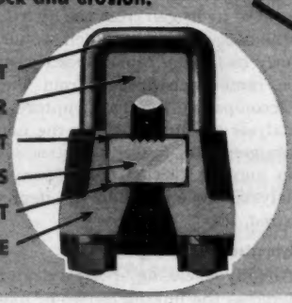

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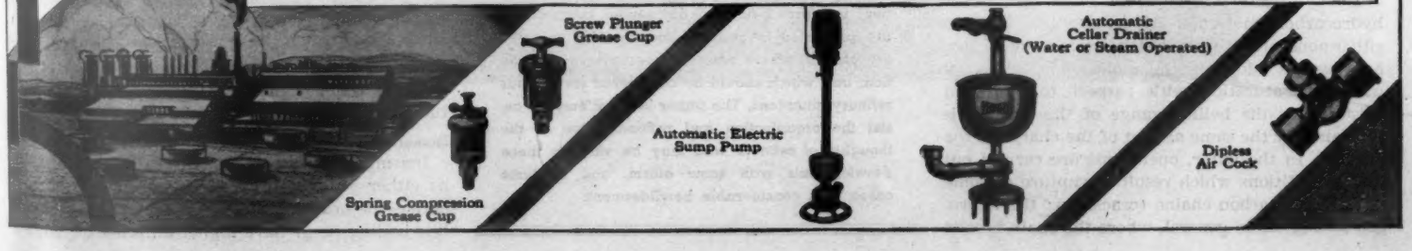
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# Petroleum-ization—1940

By HUGH W. FIELD
Atlantic Refining Co., Philadelphia, Pa.

*A.P.I.* — Presented before annual meeting, Chicago, Ill., November 13-17, 1939

THE textbook of organic chemistry which has rubbed shoulders for so long with the piping handbook and the instrument catalogue on the bookshelf of the refinery office shows fresh thumb prints. The chapter on polymerization and the definition of a catalyst were reread carefully 2 years ago. Last year the index was leafed in vain in an effort to locate "hydrocodimer"! And now, smudges are in evidence on the hitherto-clean pages dealing with isomerization, alkylation, cyclization, and aromatization. The refiner, who for half a century has been handling one of the most complex mixtures of organic chemicals known to man, at last is talking organic chemistry—or, at least, he is in there trying! Although he does not know how to make it, he has found out that neohexane is 2,2-dimethylbutane, having astounding antiknock value. Should he equip to manufacture neohexane, should he put in an alkylate plant, would it be the best bet to try catalytic cracking, or should he forget all about the whole business until somebody straightens out the tangle?

It is the purpose of this paper to attempt, in as plain language as possible, to place these various new processes on the checkerboard of petroleum refining, and determine which ones are competitive, which are complementary, and which should be considered for use as various refinery situations arise. However, due to the extremely undeveloped state of some of these processes, a crtain amount of forecasting based on personal opinion is woven into the pattern presented here, but it is hoped that this simplification and rationalization will assist the thinking which is necessary for the analysis and comparison of information which will be made available as time goes on. Discussion of the details of the operation of all of these various processes is beyond the scope of this paper; and, further, no comparison will be drawn between commercially competitive processes directed toward the same result.

## Definitions and Descriptions

A certain number of definitions and descriptions will be useful in our study of the situation; and if these definitions do not agree exactly with the organic textbook, it should be remembered that they have been drafted for "petroleum-ization" rather than for the broad field of general organic chemistry.

**Catalyst.**

A catalyst can be defined as a substance which, although present during a chemical reaction, apparently does not enter into the reaction but causes, by its presence, a change in the conditions under which that reaction occurs. Thus catalytic reactions offer a possibility for product control by selective acceleration of certain reactions which, in the opinion of many, is the most important phase of this new refining technique.

**Hydrogenation.**

The hydrogenation process adds hydrogen to the hydrocarbon molecule. Hydrogenation may be either nondestructive or destructive. In the former, hydrogen is added to the molecule only if, and where, unsaturation with respect to hydrogen exists; thus the boiling range of the product is substantially the same as that of the charge to the process. In the latter, operations are carried out under conditions which result in rupture of some of the hydrocarbon chains (cracking); the hydrogen adding on, in general, where the chain breaks have occurred. A change in boiling range results from this type of hydrogenation, the degree of change depending on the operating conditions. Nondestructive hydrogenation is generally a low-temperature low-pressure operation, whereas destructive hydrogenation operates at high temperature and high pressure. Catalysts are employed in almost all hydrogenation processes.

**Dehydrogenation.**

The general use of this term is so broad that it is practically useless. For example, the cracking of gas oil in an early Burton still involved dehydrogenation. For the purpose of this discussion, the term will be limited to operations on material in the gasoline boiling range, or lighter, and considered in two categories, as was done for hydrogenation, i.e., nondestructive and destructive. Nondestructive dehydrogenation is defined as the removal of hydrogen from the hydrocarbon molecule without the cracking which would change significantly its boiling range. Destructive dehydrogenation removes hydrogen from the molecule, but is accompanied by chain rupture to some degree. Catalysts are employed for the nondestructive dehydrogenation, but the destructive dehydrogenation may be carried out either with or without catalysts—depending on the degree of selectivity desired.

**Polymerization.**

Broadly speaking, polymerization can be considered as the linking of two or more hydrocarbon molecules to form one molecule having a longer carbon chain and a higher boiling point. Here again the definition must be narrowed to make it useful, because the tar produced when gas oil is cracked in a conventional cracking coil is the result of polymerization. Polymerization, as practiced intentionally, at the present time is confined to hydrocarbons having four carbon atoms or less to the molecule (butane and lighter), and links them together under conditions which result in the product being predominantly within the gasoline boiling range. The operation can be carried out either catalytically or thermally. The catalytic process operates at relatively high pressures, but at moderate temperatures, and only the unsaturates in the charge react. The thermal process operates at high pressures and high temperatures, but reacts both unsaturates and saturates—due in part, but not entirely, to thermal dehydrogenation taking place in the heating coil as the charge is brought to operating temperature.

**Alkylation.**

If any saturated hydrocarbon molecule is deprived of a hydrogen atom and then united with another hydrocarbon molecule through the bond where the hydrogen atom was removed, alkylation has been accomplished. The broad definition of this term leaves us nowhere, but one of the specific alkylation processes in which interest is at a high pitch at the present time unites isobutane (a branched-chain compound) with a butane (unsaturated branched or straight-chain compound) to produce practically pure isooctane. The operation is carried out at low pressure and low temperature, and requires a catalyst. Another example is the process which produces neohexane. In this process ethylene is reacted with isobutane to produce a saturated highly branched-chain six-carbon-atom compound. The neohexane process uses no catalyst.

**Desulfurization.**

In the broad sense, this term is self-defining, but here it will be considered as applying to the removal of sulfur from material within the gasoline boiling range. Chemical desulfurization, using either sulfuric acid or caustic soda, has been practiced for many years; and it should be mentioned, in passing, that strict economic comparisons must be made—the old versus the new—before completely revamping the refinery. There is, however, a definite feeling that chemical desulfurization is on the way out; so, for the purpose of this summary—which is concerned chiefly with the new catalytic processes—the definition will be narrowed to identify processes which decompose the sulfur-hydrocarbon compounds in the gasoline, and evolve the sulfur as hydrogen sulfide or possibly as sulfur dioxide. Desulfurization and dehydrogenation tend to proceed hand in hand, but the interest which is aroused at present is due to knowledge which has permitted the control of the relative rates of these two types of reactions by the use of catalysts. The now proven deleterious effect of sulfur compounds in gasoline on octane number and lead susceptibility has given a dollar impetus to further advances in desulfurization methods for sulfur removal alone. This is a distinct contrast to previous trends of thought, in which the sulfur reduction which accompanied various forms of dehydrogenation was accepted for what it was worth in meeting sulfur specifications of the gasoline—without giving too much thought to control and selectivity.

**Isomerization.**

Inasmuch as saturated hydrocarbons can exist as either straight or branched-chain compounds, and as the branched-chain compounds in the gasoline boiling range have higher antiknock qualities

## ABSTRACT

**In Petroleum-ization—1940, the numerous new processes for manufacture of high-octane gasoline, which have been filling the periodicals and the conversation of petroleum technologists during the past year or so, are discussed in plain language. Dehydrogation, alkylation, isomerization, etc., are defined and described in a manner felt to be pertinent to the present potential applications of these processes to petroleum. In addition, in chart form and discussion, comparisons are presented to assist in locating, in the refinery picture, where these processes have application, and which should be considered for various refinery situations. The paper is an attempt to assist the organization and rationalization of the thoughts of refiners who may be viewing these developments with some alarm, and in some cases with considerable bewilderment.**

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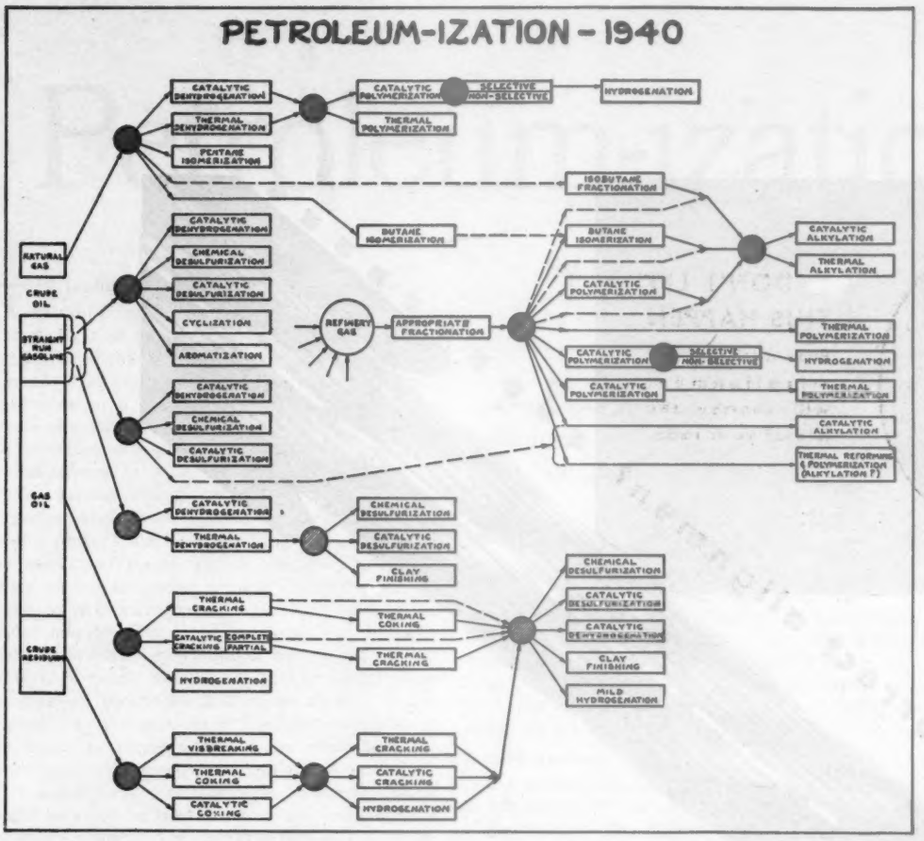


than the straight-chain compounds (e.g., isooctane vs. normal heptane, the 100 to 0, respectively, of our antiknock scale) interest in controlled changing of straight chains to branched chains (isomerization) will increase sharply if practicable methods can be discovered. Isomerization, as now available for our study as an isolated process, is confined to butane and pentane conversion to the corresponding isocompounds; but inasmuch as the extremely high octane-number increase obtained during certain catalytic-dehydrogenation operations on gasoline best can be accounted for by assuming some isomerization to have occurred, it is the opinion in many quarters that catalysts and conditions will be found eventually which will extend isomerization as a controlled process into the broad gasoline boiling range.

**Aromatization.**

For present purposes let us define aromatization as the conversion of saturated hydrocarbons to aromatic hydrocarbons, e.g., conversion of hexane to benzol, heptane to toluol, etc. Processes using catalysts at relatively high temperatures and moderate pressures have accomplished such conversions with surprisingly high yield. Aside from the "war-baby" aspect of such processes, their future probably will depend to some extent on present investigations to determine the relative merits and demerits of inclusion of aromatics in fuel for use in high-power aviation engines operating at high altitudes.

**Cyclization.**

This process is the conversion of straight-chain hydrocarbons to ring compounds (cyclics) but without the attendant dehydrogenation which necessarily takes place during the production of aromatics. The development of cyclization as a definite process is tied in with the remarks previously made about the future of aromatization. The process doubtless will be catalytic, but it is still over the horizon, and cannot enter too seriously into present thinking.

**Catalytic cracking and reforming.**

As mentioned previously, cracking involves dehydrogenation of the type defined as destructive. In the rupturing of the hydrocarbon chains, there are created fragments which are extremely active chemically. In the course of reacting to attain chemical stability, these fragments apparently, to some degree, engage in practically all of the reactions which we have been discussing. The use of a catalyst during cracking has the interesting effect of decreasing the amount of polymerization to tar and at the same time encouraging aromatization and isomerization of the cracked fractions in the gasoline boiling range. As a result, material of high antiknock value is produced. In catalytic reforming a different effect is sought. Here aromatization and isomerization are encouraged by different operating conditions and catalysts, but every effort is made to suppress the chain rupture which would cause excessive conversion of gasoline to gas. In the following discussion, catalytic reforming is classified as dehydrogenation, but merely for convenience, and does not infer that the dehydrogenation phase is considered predominant.

**Coking.**

The operation of coking, whether thermal or catalytic, consists of heat-treating heavy hydrocarbons, usually crude residuum or cracked tar, in order to increase the ultimate yield of gasoline from the crude. Heavy hydrocarbons are low in hydrogen-carbon ratio; gasoline is relatively high in this same ratio. The conversion, therefore, necessitates the throwing out of carbon (coke) as a means of adjustment of this ratio. Catalytic coking, as contrasted with thermal coking, results in less coke "throwout" for a given conversion, possibly due to the fact that gasolines of relatively high aromatic content have a lower hydrogen-carbon ratio than nonaromatic gasolines, and lower carbon "throwout" would suffice for the adjustment in hydrogen-carbon ratio necessitated by this type of conversion. It is important to note that the carbon produced in the catalytic operation deposits in the pores of the catalyst; therefore, extensive steam generators must be included as a part of the plant investment if the heating value of the carbon is to be put to use when the catalyst is regenerated.

## Refinery Applications

Having had a general look at these new processes, the refinery picture should be examined for possible applications. For this purpose a chart has been prepared, which starts with crude petroleum and presents some of the various courses which might be plotted in converting this crude to gasoline as the major product. The shaded circles are positions where a stop is made to review ways and means, before taking the next step.

**Natural gas.**

The natural gas, butane and lighter (except when pentane isomerization is indicated) can be converted to either high-octane motor gasoline or to aviation gasoline. Because natural gas is, in general, completely saturated, either catalytic or thermal dehydrogenation is necessary. If motor gasoline is the goal, this choice is governed by investment and operating-cost estimates. If aviation gasoline is desired, or if flexibility for future changes to aviation production is a requirement, the choice probably will be catalytic.

Essentially the same reasoning applies to choice of type of polymerization unit. If aviation gasoline is not desired, the investment comparison must take cognizance of the fact that the dehydrogenation is an integral part of the thermal-polymerization plant.

If a catalytic-polymerization plant is chosen, the decision must be made between selective operation for codimer (isooctene) followed by hydrogenation to hydrocodimer (isooctane) or nonselective operation for a higher yield of high-octane (80+) motor fuel. Perhaps a plant built for selective operation, but operated for motor fuel and without hydrogenation, is indicated in order to avoid closing the door to future aviation-gasoline production from this stream.

If hydrocodimer is produced, a high-octane front-end volatility correctant can be prepared by isomerizing some of the normal pentanes in the crude to isopentane. This step is indicated if the loss in octane rating of the hydrocodimer when blended with natural gasoline is sufficient to justify the investment and operation of such a plant.

The indicated approach to isobutane fractionation or butane isomerization will be discussed in connection with handling refinery gas.

**Straightrun gasoline.**

The light fraction of the straightrun gasoline may be subjected to catalytic dehydrogenation (catalytic reforming) for the purpose of making a high-octane (85+) aviation fuel with good lead susceptibility. If the octane-number increase does not justify the sacrifice in yield which accompanies the reforming, catalytic desulfurization alone may be indicated to produce low-sulfur stocks for special naphthas or to take advantage of the increase in lead susceptibility which results from the sulfur removal alone. As previously mentioned, this latter step must stand the careful economic scrutiny of comparison to chemical treatment.

Cyclization to increase antiknock value without conversion to unsaturates or aromatics may be a profitable possibility in the future.

Aromatization will produce aromatics which may have value as a component of the aviation fuel of the future. If the process can be developed to a position competitive with other methods of antiknock increase from a cost standpoint and material degradation, a wide application will be made, inasmuch as the motor-fuel blending stock produced has a much higher octane value when measured by the A.S.T.M. motor method.

The entire straightrun gasoline can be dehydrogenated catalytically or desulfurized, with the choice developed using the same reasoning that was used for the light fraction. The straightrun gasoline available also should be kept in mind when laying plans for processing the refinery gas, as will be seen later.

The heavy straightrun gasoline, long the standard charge for thermal reforming, can be dehydrogenated catalytically to produce a high yield of high-octane desulfurized blending stock. However, it should be remembered in planning this operation that the change in boiling range is much less with

catalytic than with thermal dehydrogenation. If thermal reforming has been used to control overall gasoline volatility for the refinery, care must be taken, or the entire plant-volatility balance may be upset by this loss of front-end volatility. If this develops to be serious, this fraction may be left for thermal reforming; but, inasmuch as the desulfurization obtained is less than half that which would have been experienced by using the catalytic unit, catalytic desulfurization of the thermally-reformed naphtha may be justified. As a last possibility, if the sulfur situation is not serious and the catalytic desulfurization cannot be justified, the good old standbys, vapor-phase clay treatment or chemical treatment, may be used.

**Gas oil.**

The gas-oil fraction from the crude may be charged to the exisiting thermal-cracking units. This is a cheap way to make gasoline from gas oil; and, inasmuch as we still are learning more every day about how to operate thermal-cracking coils, let us not be too hasty in discarding these reliable units. Some discarding may be necessary, but we must be certain that the change is an improvement, and not just a change.

If the refinery is situated so that heavy fuel oil is difficult to market, thermal coking may be indicated on the cracked tar; but the refractory gas oil obtained from this type of coking generally is conceded to be a poor cracking stock. A careful economic analysis is necessary to make the decision, and this analysis should be repeated at intervals as refinery markets change to determine the advisability of continuing the operation.

If analysis indicates that some or all of the gas oil should be cracked catalytically to produce high-octane (76+) gasoline, a decision must be made as to whether the operation will be partial (once-through) or complete (recycled to ultimate gasoline yield). The type of process and the stock to be handled must be examined critically in order to reach a decision on this point. If a once-through operation is practiced, the catalytic recycle can be handled in thermal-cracking coils (possibly existing) for completion of the conversion. If a furnace-oil market exists that can absorb this catalytic recycle, the situation is improved—inasmuch as the opinion persists that the recycle gas oil from a catalytic cracking unit is not the easiest thing to handle from a cost standpoint for further processing either catalytically or thermally.

The gas oil may be considered as a possible charge for a destructive-hydrogenation unit; but information at present indicates that, unless specialty products are desired, the lower-octane value of the gasoline, plus the high investment and manufacturing costs, it not offset by the high ultimate yield and the high quality of the gasoline in respects other than octane value. Present product-price structures do not favor hydrogenation at this point.

**Crude residuum.**

The crude residuum or natural tar may be charged either to a thermal viscosity breaker to obtain maximum gasoline without running to coke, to a thermal coking unit to obtain a higher ultimate gasoline yield, or to a catalytic-coking unit to obtain the highest yield which can be obtained without hydrogenation. If the catalytic unit is considered, possible duplication of steam-generating facilities must be evaluated. Although some gasoline is produced directly in these operations, the prime function in all is the production of gas oil for subsequent conversion to gasoline. This gas oil is similar to the gas oil from the crude, and may be considered in the same category for purposes of simplification.

**Cracked gasoline.**

The finishing of cracked gasolines can take four possible major routes. If octane level is satisfactory, catalytic or chemical desulfurization may be indicated; but a word of caution is necessary here. Data from catalytic desulfurization of straightrun gasolines show extremely satisfactory results; but, in attempting to handle cracked gasolines in the same manner, some processes have had trouble obtaining the required degree of desulfurization without resorting to operating conditions which resulted in excessive yield loss by polymerization or dehydrogenation.

If the octane level is unsatisfactorily low on the cracked gasoline, catalytic dehydrogenation should be given consideration. Although thermal reforming seldom has been an economically-sound operation applied to cracked gasolines, there are definite indciations that catalytic operations have possibilities in this respect.

Vapor-phase clay treatment, or chemical treatment, is the answer if neither sulfur nor octane value requires serious attention; but this phase of refining should not be passed without looking at hydrogenation. The possibilities in hydrogenation for sulfur removal, in the event the catalytic-desulfurization processes fall down on cracked gasolines, should not be overlooked. This hydrogenation would be mild in character, using catalysts which would function in low-cost low-pressure plants, and operating in such a manner as to remove sulfur selectively without seriously reducing the octane level.

**Refinery gas.**

Most of the operations considered up to this point produce some gas in addition to liquid products. This gas can be a very profitable source of either aviation gasoline or motor fuel. The various steps that can be taken to realize profits from this situation are quite varied, particularly as much depends on the type of gas available which, in turn, is a function of crude run and previous processing methods. The best that can be done here is to discuss the possibilities and indicate the type of thinking necessary to evaluate a given situation.

If a catalytic-alkylation plant is being considered for production of aviation gasoline (96+ octane), three possible channels must be considered. These three considerations are necessitated by the requirement that the feed to the alkylate plant must contain isobutane and butenes in molecular ratio of slightly more than 1 to 1. Most refinery gases contain one-third to one-half the quantity of isobutane necessary to supply this requirement; and, if no steps are taken to correct the situation, the alkylate produced will be too low in octane rating.

The first possibility is fractionation of natural gas for its isobutane content and addition of this to the refinery gas in proper amounts to meet the requirements. This necessitates having available and handling large quantities of natural gas.

The second possibility is isomerization of butane to isobutane to a sufficient degree to build up the isobutane-butene ratio. In refineries having highly unsaturated gas it may be necessary, in addition to this, to isomerize some of the butane from natural gas to augment the isobutane available.

The third possibility lies in the other direction, i.e., reduction of the content of butenes, by catalytically polymerizing some of these butenes. The butanes pass through this process unchanged; and although in a given refinery this method produces considerably less alkylate, it does produce, more or less as a by-product, high-octane polymer gasoline for use as a motor-fuel blending stock.

Both catalytic and thermal-alkylation processes are shown on the chart. As previously mentioned, the eight-carbon-atom alkylate is made in a catalytic process now commercially available. The thermal-alkylation process previously mentioned which produces neohexane, a six-carbon-atom alkylate, is not as completely developed at present, but is sufficiently close in accomplishment to be considered competitive for this survey—particularly as the thermal alkylate is a superior product in antiknock value (120+ vs. 96+).

If motor fuel is the goal in processing the refinery gas, polymerization should be considered; inasmuch as, at the present time, an alkylation plant is difficult, if not impossible, to justify economically for motor-fuel production.

Thermal-polymerization units have a high investment cost, but do produce high yields of high-octane (76+) gasoline. This high yield is due to the inherent dehydrogenation which takes place in the plant heating coils, plus a certain amount of alkylation which occurs between the saturates and unsaturates. In addition to the octane credit, the thermal polymer should be given a high volatility credit. Thermal polymer gasoline is extremely rich in front-end volatility; and, properly evaluated, this credit may amount to more than the octane credit.

Catalytic polymerization, if operated selectively and in conjunction with a hydrogenation unit, is directly competitive with the alkylation process in producing isooctane. In this comparison of processes, the possible necessity for isomerization of butane for the alkylation plant must be considered and compared with the probable necessity for isomerization of pentane as a blending stock for the hydrocodimer. Alkylate has inherently better front-end volatility characteristics than hydrocodimer, which may give the alklation process an economic advantage in certain circumstances.

If a nonselective catalytic-polymerization plant is being considered, the competition is with the thermal unit—both being considered for motor-fuel production. Inasmuch as the catalytic unit reacts only the unsaturates, the ultimate gasoline yield from a given gas stream is considerably lower. However, the investment and operating costs are substantially lower, and units much smaller in capacity than would be practicable for a thermal unit can be considered. The catalytic-polymerization unit is definitely a "cream skinner," with a quick payoff and, as such, should be examined carefully, particularly for a small refinery.

In a large refinery the application for catalytic polymerization well may be in conjunction with a thermal unit, utilizing the "skimming" effect cheaply to polymerize the unsaturates—the thermal unit following to complete the cleanup. Further, excess or standby capacity for peak or abnormal loads can be installed and operated cheaper catalytically than thermally. For the large refinery this combination of catalytic and thermal polymerization is probably the most flexible setup that can be obtained commercially at the present time. This is particularly true if the catalytic plant is designed for either selective or nonselective operation.

The possibility of catalytic dehydrogenation prior to catalytic polymerization has not been discussed in connection with refinery gas, but was mentioned for natural gas. Processing natural gas, particularly for aviation gasoline, seems to be the most promising place for application of this combination at the present time, due to the relatively high investment costs for butane-dehydrogenation equipment. If this situation changes in the future, and it is believed that it will, consideration should be given to refinery-gas applications for catalytic dehydrogenation.

The last two processes indicated handling refinery gas, and involve simultaneous processing of the straightrun gasoline from the crude. Thermal reforming and concurrent gas polymerization was developed initially in an effort to give the small refinery a chance to obtain the advantages of thermal polymerization by combining the operation with thermal reforming, in the same coil. Developments have shown that more than concurrent reforming and polymerization take place. Possibly both alkylation and isomerization play a role in the surprisingly satisfactory results obtained. The possibilities of such combined processing should not be neglected in studying a large refinery, par-

*(Continued on Page 271)*

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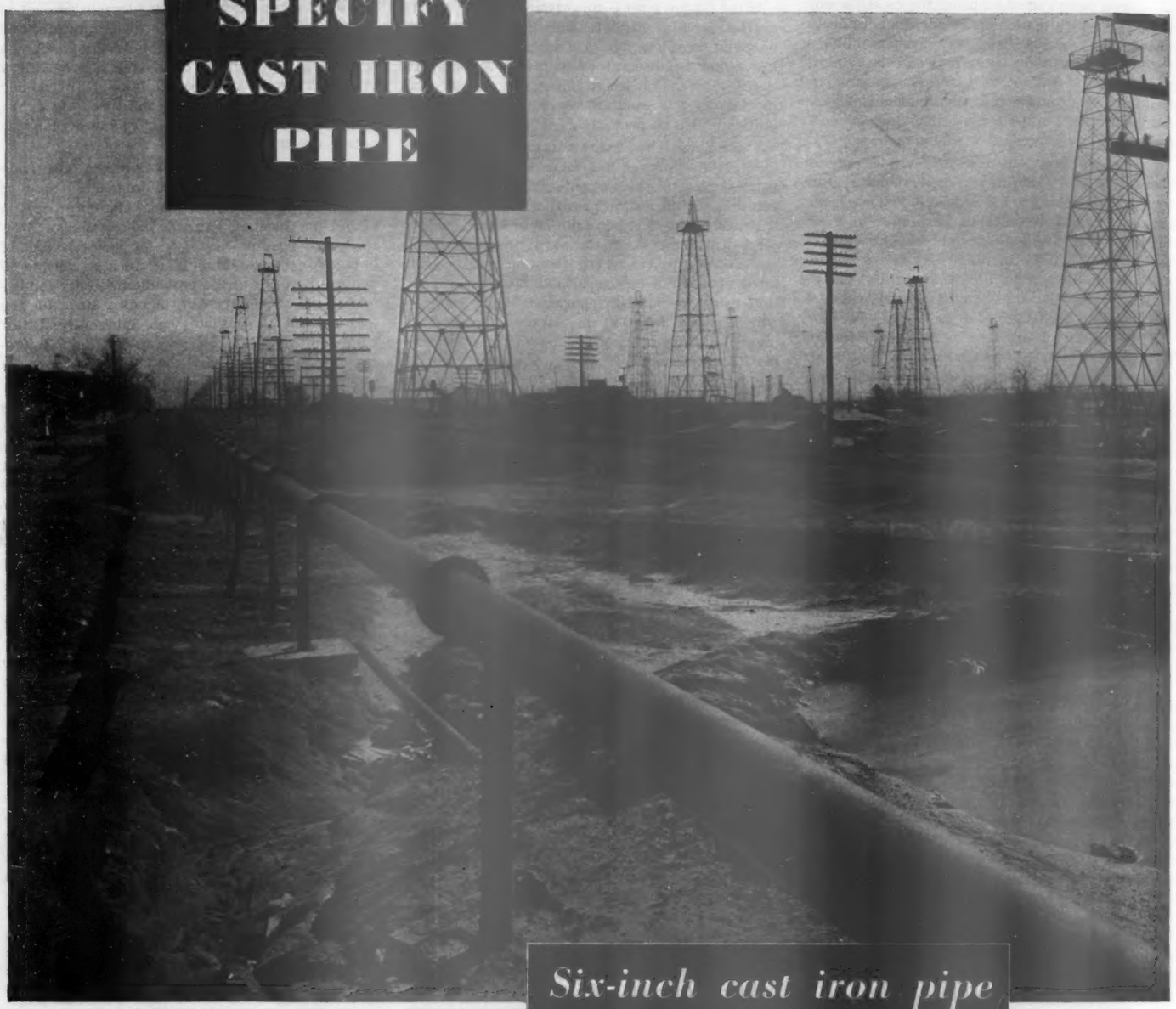

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By D. P. BARNARD
Standard Oil Co. (Indiana), Whiting, Ind.

## ABSTRACT

**The A.P.I. hydrocarbon research project was initiated September 1, 1938, for the purpose of preparing as many gasoline-range hydrocarbons as possible and examining them for their basic engine-combustion characteristics, physical and thermal properties, etc. No extensive chemical studies are anticipated. The program is sponsored by 25 interested companies. The hydrocarbon preparation is being carried out by Prof. C. E. Boord, of Ohio State University Research Foundation. Engine studies, which consist of conventional A.S.T.M. and C.F.R. research ratings, plus the determination of permissible critical compression ratios under four widely varying conditions of service, are being conducted by the Research Laboratories of the General Motors Corp. Physical and thermal-property determinations are to be conducted by individuals who are engaged in research upon the particular properties under consideration. To such investigators, the project will make available highly purified hydrocarbons in reasonable quantities.**

**Up to the present about 12 hydrocarbons, all in the 8-carbon-atom range, have been prepared and submitted for engine examination. In addition, a considerable number of hydrocarbons are in the process of examination, or have been completed, with the exception of final purification. It is anticipated that approximately 40 hydrocarbons will be prepared and examined during the present year. It was not possible to complete the work on very many hydrocarbons during the first year, as much of the time was utilized in organizing the staff of the hydrocarbon laboratory at Ohio State University and in working out the details of the engine-test procedure. The basic method used for engine studies consists in determining the critical compression ratios over a wide severity range, which includes conditions less severe than the C.F.R. research method, to a set of conditions which has been demonstrated to be more severe than those ordinarily encountered in aircraft practice. No attempt is being made to centralize either the preparation or examination of work upon hydrocarbons of any particular characteristic or for any special type of service. The basic plan is to map the gasoline-range field as thoroughly as possible for the purpose of providing a background for any specialized development work which individual organizations may wish to undertake.**

**The present paper has been prepared primarily to outline the objectives of the project; and the method of attack and subsequent papers, to be given by individual investigators, will present experimental results.**

THE A.P.I. hydrocarbon project was undertaken as the result of a rapidly increasing need for basic data on the combustion characteristics of gasoline hydrocarbons to be used as guides in the solution of problems encountered in the development and utilization of internal-combustion-engine fuels. There also exists an acuate demand for more complete and accurate physical and thermal data for many of the hydrocarbons in this range than now exist. Several excellent compilations of the latter type of data, plus knock ratings by conventional methods, are available. A scrutiny of these compilations, however, reveals a large number of blank spaces along with many items which, in the light of present knowledge, are either incomplete or of questionable accuracy. In particular, knock ratings by the conventional laboratory methods are unsatisfactory from a basic point of view, as it is recognized by all who intimately are concerned with this type of work that behavior under many conditions of utilization rarely can be predicted

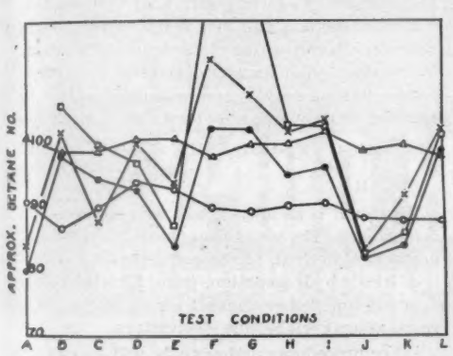



*Fig. 1—Variation in apparent knocking behavior, of five fuels of widely differing compositions, with 12 test conditions*

from such ratings. This is illustrated in Fig. 1, which compares the knocking behaviors of five fuels under 12 different test conditions.

The project was undertaken as the direct result of the voicing of the above need (during an informal discussion following a C.F.R.* meeting early in 1938) and a proposal by the Research Foundation of Ohio State University inviting support for a program aimed primarily at research upon methods of hydrocarbon preparation. As originally expressed, the two proposals represented quite divergent aims: the former involved the extensive examination of a large number of representative hydrocarbons (which necessarily would be required in rather large quantities in order to permit comprehensive engine studies); the latter to investigate methods of preparation—the question of quantity being quite unimportant. The objectives of the two programs were discussed thoroughly, with the result that Professor Boord of Ohio State University, department of chemistry (who was interested primarily in the preparation proposal), agreed to extend the scope of that project to provide quantities sufficient for engine research purposes. These discussions culminated in a meeting of the interested parties at Wichita, Kans., at the time of the 1938 Institute's mid-year meeting. It was the vote of the group present that the work be undertaken, and that it be sponsored by the American Petroleum Institute. An application for such sponsorship subsequently was acted upon favorably by the directors of the American Petroleum Institute, the understanding being that the project would furnish its own funds.

As finally organized, for the first year the project had 25 supporting organizations. Work upon this project was begun officially on September 1, 1938, and the first year's activities terminated August 31, 1939. The project has been renewed for a second year beginning September 1, 1939, with 24 supporting organizations.

***A.P.I.*** **— Presented before annual meeting, Chicago, Ill., November 13-17, 1939**

### General Program

**1. Organization and administration.**

The general plans under which the work is being carried out were formulated at the initial meeting held in August 1938. The basis for organizing the program was as follows:

1. As many hydrocarbons falling in the gasoline-volatility range will be prepared as experience should find possible and practical. These hydrocarbons should be available in sufficient quantity to permit the carrying out of a basic study of engine-knocking characteristics and a reasonably complete examination of their physical and thermal properties. No restrictions will be placed upon the type of hydrocarbons to be prepared—it being understood thoroughly that the program is to be of a basic research nature, and not one of specific product development.

2. The hydrocarbons are to be subjected to the most basic possible study of their knocking characteristics.

3. Physical and thermal characteristics are to be determined both for purposes of identification, and to amplify the existing data upon these points.

*Cooperative Fuel Research Committee.

4. No extensive studies of chemical characteristics are contemplated.

5. The results of all findings are to be made public. The committee further went on record: "While it is not anticipated that patentable developments will arise out of this project, it is understood that if such should arise, benefits will be dedicated to the public by publication or otherwise."

6. It was recommended that the Research Foundation of Ohio State University undertake to secure—and, when necessary, to prepare—hydrocarbons falling within the scope of the project.

7. The research laboratories of General Motors Corp. were requested to undertake the engine studies.

8. The determinations of physical and thermal properties are to be carried out by whatever procedure appears to be most expedient in individual cases.

The broad plan adopted at the first meeting of the hydrocarbon research committee anticipated that the work probably would extend over a period of approximately 4 years. It was felt, however, that support should be given upon an annual basis, with the decision for each succeeding year's support contingent upon progress. It was not anticipated that all of the hydrocarbons falling in the gasoline range will be prepared and examined under the above-mentioned conditions, within the time indicated. This would be a physical impossibility, as is indicated by the tremendous number of hydrocarbons which are theoretically possible in the gasoline-volatility range. It was determined, however, that hydrocarbons broadly representative of the various types which possibly might be employed as internal-combustion-engine fuels would be investigated to the fullest possible extent.

The project currently is administered by a committee consisting of a representative of each organization supporting the project. This committee met upon three occasions during the first year of the program. One meeting was held in August 1938 for the purpose of organizing and authorizing work and expenditures under the project. Meetings also were held at the time of the 1938 annual meeting and the 1939 midyear meeting of the Institute. Another meeting of this committee will be held at the time of the 1939 annual meeting. Handling of detailed questions rests with a small advisory committee. A complete list of the project underwriters and their representatives is attached as Appendix 1 of this report.

**2. Hydrocarbon preparation and procurement.**

As indicated hereinbefore, no attempt is being made to prepare or secure all of the hydrocarbons falling within the gasoline-volatility range. The hopelessness of such an ambition is indicated by the tabulation which shows the number of isomers possible in the $C_5$ to $C_{12}$ range.

Accordingly, selection of the hydrocarbons to be prepared is being determined largely by practical considerations. In general, it is felt that the scope should be restricted to those hydrocarbons falling within the $C_5$ to $C_{12}$ range, inclusive. In the first year's work particular emphasis was placed upon the preparation of the 8-carbon-atom paraffins. Hydrocarbon preparation was delegated to the Research Foundation of Ohio State University —with the understanding that a suitable personnel organization would be created, and that the necessary physical facilities would be acquired. All out-of-pocket expenses directly resulting from the prosecution of the project were to be borne by the supporters of the project. A suitable budget was prepared for the first year, and work was begun officially in September 1938. The original Ohio State University proposal involved research into methods of preparation only with the idea that the quantities actually to be prepared would be quite small. The most frugal engine procedure which could be devised indicated that at least 1 gal. would be required. Accordingly, the methods of attack originally proposed by Ohio State University were revised, with the idea that at least 1¼ gal. of each hydrocarbon would be made available. The minimum of 1 gal. would be required for the basic engine studies, whereas 500 ml. of material of the highest possible degree of purity was to be available for physical and thermal-property examination.

| Carbon atoms | Isomers: Paraffins* ($C_nH_{2n+2}$) | Isomers: Olefins† ($C_nH_{2n}$) |
|---|---|---|
| 5 | 3 | 5 |
| 6 | 5 | 13 |
| 7 | 9 | 27 |
| 8 | 18 | 66 |
| 9 | 35 | 153 |
| 10 | 75 | 377 |
| 11 | 159 | 914 |
| 12 | 355 | 2,281 |

*Hanze and Blair, J. Am. Chem. Soc. 53, 3077.
†Hanze and Blair, J. Am. Chem. Soc. 55, 680.

**3. Engine studies.**

The carrying out of the engine research work was delegated to the research laboratories of the General Motors Corp., particularly as this organization had contributed already a considerable portion of the available basic information bearing on the principal objective of the project. A thorough study was made of a possible means of attack, with the result that a series of four tests involving the determination of critical compression ratios under widely varying severity conditions was recommended to the committee, and selected as the basic engine study. These tests are supported by A.S.T.M. and research octane numbers upon the hydrocarbons either direct or when blended with a 60-40-octane-heptane base (in the event that their initial octane numbers are above 70). These latter observations include additions of 1 ml. and 3 ml. of tetraethyl lead per gallon. The program also provides for studies at varying mixture ratios, when availability of the hydrocarbons will permit. It was agreed that this work would be amplified, whenever possible, by other engine studies such as supercharge tests. The initial work has included the examination of a series of easily obtainable fuels representing a wide variation in type under a large number of test conditions. The net result of this work is to indicate the practicability of the method of approach that has been followed. It should be emphasized that an important consideration in setting the scope of the basic engine-test program is the limitation imposed by the quantities which can be prepared by practical procedures.

**4. Physical and thermal properties.**

No definite plans have been drawn up for the conduct of physical and thermal-property studies. It has been the feeling of the committee that such work best can be done by specialists in particular fields of research. Accordingly, it is the plan of the project to make the purified hydrocarbons available to competent research workers—the understanding being that the information obtained will be made available promptly to the committee, but that the individual worker will have the right to independent publication of his results. In addition, the project is cooperating with the national Bureau of Standards, which is engaged in a hydrocarbon research program of a more specialized nature under the sponsorship of the National Advisory Committee for Aeronautics.

## Hydrocarbon Preparation

**1. Personnel.**

The work of procuring those hydrocarbons already available from other sources, and preparing those otherwise unobtainable, was delegated to the Research Foundation of Ohio State University. A "hydrocarbon laboratory" has been established under the general supervision of C. E. Boord, professor of organic chemistry. A research staff has been established as follows:

A. L. Henne, research associate in charge.

One research assistant.

Three graduate fellows (half time).

In addition, the services of another research assistant and three graduate fellows have been utilized for comparatively short periods. It is anticipated that this basic arrangement will be employed for the entire program. Whether it will be amplified at some later date will be determined by subsequent developments.

**2. Preparation procedures.**

Certain of the hydrocarbons falling within the scope of this project are obtainable without recourse to laboratory preparation. Accordingly, as many as possible have been procured and purified —whenever necessary—at Ohio State University. For example, the following is a partial list of the hydrocarbons obtained in this manner:

Benzene.
Toluene
Ethyl benzene
*m*-Xylene
*o*-Xylene
Cyclohexane
Methylcyclohexane
3-hexane
2,2,4-trimethylpentane
*n*-Heptane.

Three principal procedures have been employed thus far in preparing hydrocarbons as follows:

*a.* A mixture of olefins having the desired skeletal structure is produced by dehydration of the appropriate tertiary carbinol. If the three alkyl groups of the carbinol are the same, a single olefin is obtained; otherwise the mixture is difficult to separate into its components. The carbinol is synthesized by the reaction of a Grignard reagent with a ketone or ester, the Grignard reagent being formed by the action of an alkyl halide on metallic magnesium in dry ether. This reaction briefly may be formulated as follows:

$$R-\overset{\overset{O}{\parallel}}{C}-R'' + R''MgX \rightarrow R-\overset{\overset{R''}{|}}{\underset{\underset{R''}{|}}{C}}-OH$$

Where *R*, *R'* and *R''* are alkyl groups, and *X* is a halogen. It is necessary to add the ketone or ester in ether slowly to the Grignard reagent because of the large amount of heat produced. If desired, the olefin (or mixture of olefins) may be hydrogenated to form a saturated hydrocarbon.

*b.* This method also makes use of the Grignard reaction. However, the olefin is produced directly by the reaction of the appropriate alkylmagnesium halide with an alkyl-type unsaturated halide. The reaction briefly may be formulated as follows:

$$H_2C=\underset{\underset{R}{|}}{C}-\underset{\underset{H_2}{|}}{C}-X + R'MgX \rightarrow H_2C=\underset{\underset{R}{|}}{C}-\underset{\underset{H_2}{|}}{C}-R + MgX_2$$

Where: *R* is an alkyl group or hydrogen, and *X* is a halogen. The olefin thus formed may be hydrogenated, if desired, to the corresponding paraffin.

*c.* Direct hydrogenation, using a nickel catalyst, also is employed to convert aromatics to the corresponding cyclohexane derivatives.

Other procedures undoubtedly will be employed in the course of time. It is possible, however, to prepare a great many hydrocarbons of the various types by appropriate combinations of the above methods. The first method has been used most extensively up to the present.

Very few reactions can be trusted to give pure products, with the result that certain steps are necessary in order to insure that the resulting hydrocarbons will be of satisfactory purity. A procedure which largely is standardized has been employed as follows:

*a.* Fractionation of the crude olefin through one of the metal total-reflux columns.

*b.* Examination of the main fraction for residual halide, ketone, or ester, and chemical treatment for their removal if present.

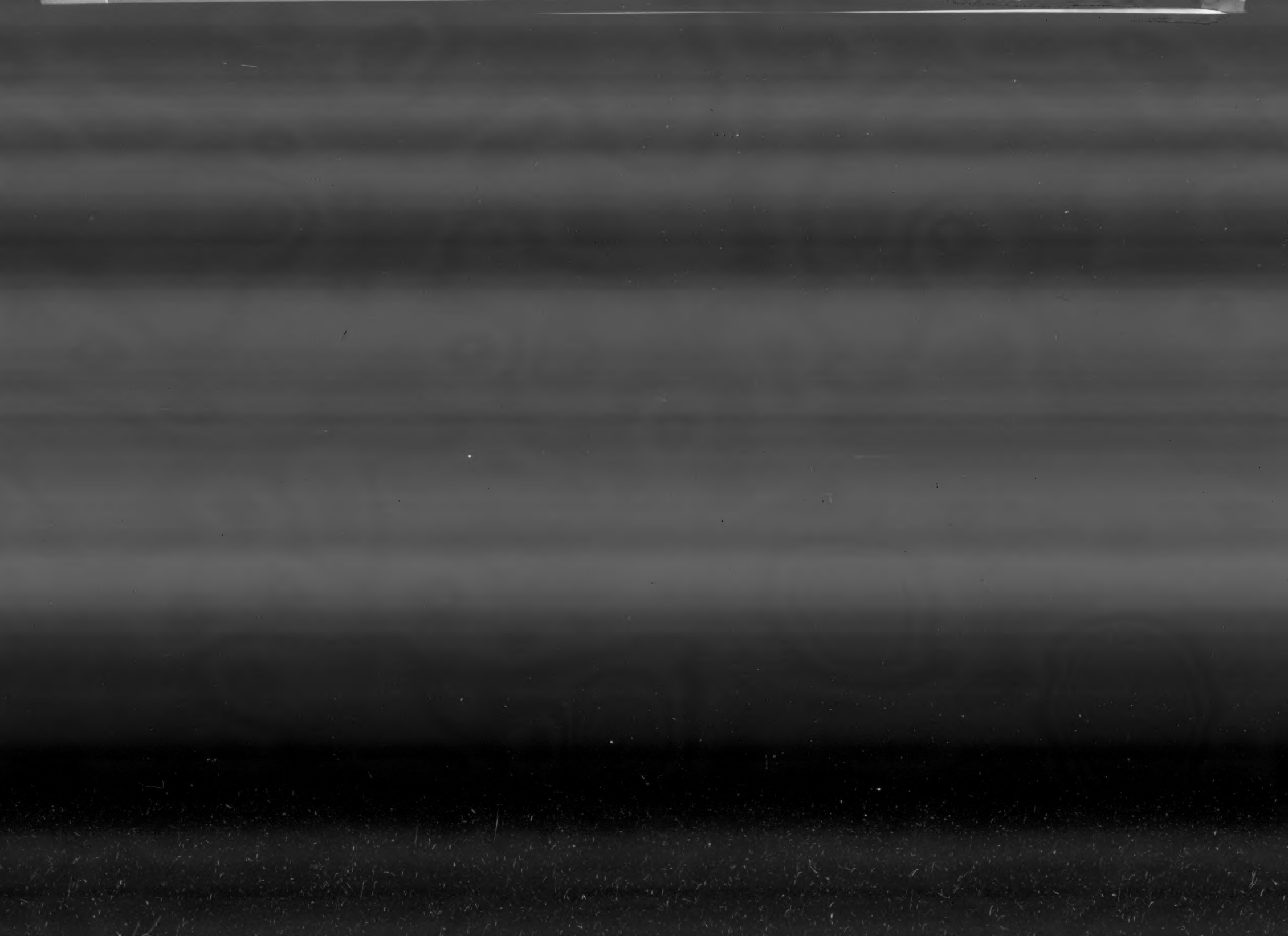
*c.* Hydrogenation.

*d.* Refractionation collecting as "heads," "main fraction," and "tails," and examining each for residual olefin or other impurities.

*e.* Rehydrogenation over fresh catalyst.

*f.* Washing with strong sulfuric acid, if necessary.

*(Continued on Page 122)*



# 2400 H.P. of CLARK "ANGLES"

## in a recently enlarged gasoline and repressuring plant

the K.M.A. Field. The first order was for 5 4-cylinder, 400 H.P. CLARK "Angles" and was received in June, 1938. Three more were ordered in March, 1939, five more in July, 1939.

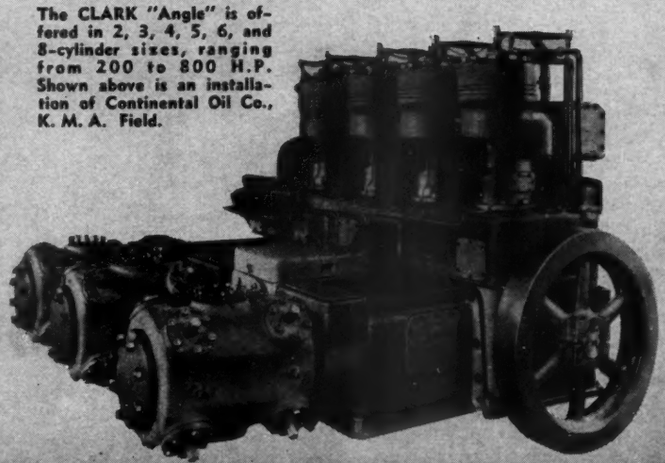
Allow us to explain in detail the important economies introduced by this machine, in transportation, installation, fuel consumption and maintenance.

CLARK BROS. CO., INC. . . . Olean, New York, U.S.A.

Export Offices: 30 Rockefeller Plaza, New York. Domestic Sales Offices and Warehouses: Tulsa, Okla.; Houston, Texas; Chicago, Ill.; Boston, Mass. (131 Clarendon St.); West Coast Office: Smith-Booth-Usher Co., Los Angeles, Cal. Foreign Offices: 72 Turnmill St., E. C. 1, London; 4 Str. General Poetas, Bucharest, Roumania.

RK

The CLARK "Angle" is offered in 2, 3, 4, 5, 6, and 8-cylinder sizes, ranging from 200 to 800 H.P. Shown above is an installation of Continental Oil Co., K. M. A. Field.



*g.* Final distillation through all-glass columns collecting in 100-ml. portions, and constructing distillation and refractive-index curves.

The degree of purity (for paraffins) is determined by the following tests:

*a.* Absence of halides (modified Beilstein test).

*b.* Insolubility in concentrated sulfuric acid.

*c.* Absence of unsaturation (bromine test).

*d.* Absence of peroxides (acidified potassium-iodide test).

*e.* Flat distillation curve (no more than 0.1° C. on accepted portion of curve).

*f.* Flat refractive-index curve (no more than 0.0001 variation in $n^{20}_D$ on accepted portion of curve).

*g.* Flat, reproducible freezing and melting curves.

At the end of the first year of operation, the

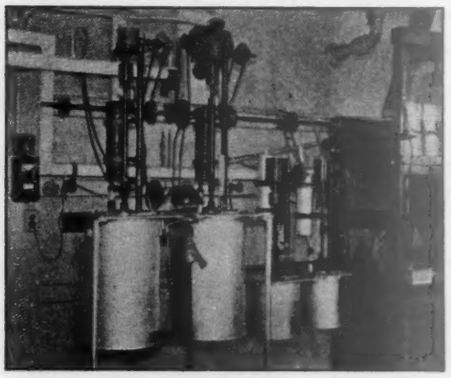


*Fig. 2—Grignard reactors*

hydrocarbon laboratory had the following equipment available:

Four Grignard reactors:

- One 3-gal. capacity (copper lined).
- One 5-gal. capacity (steel).
- Two 15-gal. capacity (steel).

Four metal total-reflux columns (40-45 plates).

Eight still pots (interchangeable on above columns):

- Three 1.5-gal. capacity.
- Three 3-gal capacity.
- Two 5-gal. capacity.
- Three all-glass total-reflux columns (23-28 plates).
- One cracking still and furnace.
- One chemical washer.
- One refrigerating unit for control of reactors and condensers.
- One mechanical refrigerator (old).

In addition to the above, the laboratory has the use of the following equipment provided by the university:

- One American Instrument Co. super-pressure autoclave, 3,000-ml. capacity and with automatic thermostatic control.
- One Abbe refractometer.
- One freezing-point-melting-point apparatus with Leeds & Northrup Micromax recorder.

This equipment is installed in the main chemistry building, a large laboratory room having been made available for this purpose. Figs. 2, 3 and 4 show the more important apparatus items and their installation.

Plans for the second year of the program provide for the construction of a small building to house the large Grignard reactors and such other apparatus as is deemed too large for proper operation in the main laboratory building, as shown in Fig. 5. It is planned also to extend the distillation equipment, and to add another hydrogenator. With these additions, it is anticipated that about 40 hydrocarbons can be prepared and purified during this year, in quantities suitable for engine-combustion studies and physical and thermal-property determinations.

## Engine-Combustion Studies

In the organizing of the program, the General Motors research laboratories accepted the assignment of carrying out the engine-research program. During the first year this activity was supervised by T. A. Boyd, with direct assistance from W. G. Lovell and J. M. Campbell. During the second year the work is being continued by Lovell and Campbell. The procedures employed for the basic studies were developed by the fuel section of the General Motors research laboratories, and are discussed as follows:

*General problem of knock measurement.*—On account of the importance of antiknock quality in determining the potential usefulness of a fuel in the conventional spark-ignition engine, the measurement of knocking tendency is an important phase of this investigation. This problem is complicated greatly by the fact that the relative knocking tendencies of different fuels change with changes in engine conditions. This is particularly true of pure hydrocarbons, in which the characteristics of each hydrocarbon are not obscured by the presence of other materials. It, therefore, has been desirable to obtain as broad a foundation of knowledge of the knocking characteristics of each hydrocarbon as possible.

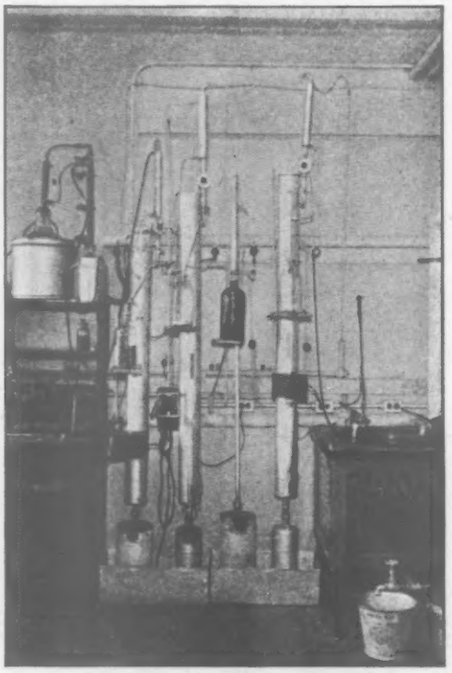


*Fig. 3—40-45 Plate total-reflux columns*

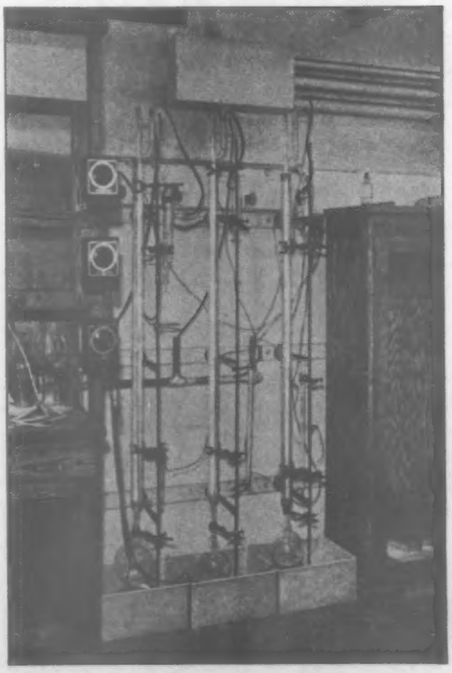


*Fig. 4—23-28 Plate total-reflux columns*

*Conventional A.S.T.M. and C.F.R. research knock tests.*—As a first step in this direction, the octane numbers of each hydrocarbon are to be determined by the conventional A.S.T.M. test, D 357-39, and by the C.F.R. research (1939) method of test. This part of the program involves the following tests by each method:

1. Octane numbers on pure hydrocarbon.
2. Lead susceptibilities in concentrations of 1.0 ml. and 3.0 ml. of tetraethyl lead per U. S. gal., when A.S.T.M. and research octane numbers can be obtained.
3. Blending octane numbers for fuels of 70-octane number, or higher, by the A.S.T.M. method in a 20 per cent concentration in a base fuel composed of 60 per cent isooctane and 40 per cent *n*-heptane.

These tests require approximately 2,000 ml. of fuel.

The results obtained by these two methods of test are expressed in octane numbers, whenever possible; and, consequently, have the advantage of a terminology that is in familiar use. However, both of these methods were developed especially for, and best are suited for, rating commercial gasolines in the limited octane range between approximately 50 and 85-octane number. The application of these methods to fuels outside of this range of octane numbers—particularly to fuels above 100 in octane number—has not been altogether satisfactory, for a number of reasons. This has been partly because of limitations in the instrumentation; partly because of limitations of the reference fuels; and partly because of the arbitrary combination of engine speed, mixture temperature, and ignition timing in the A.S.T.M. procedure for the purpose of producing a given effect, viz., an approach to correlation with road-test ratings.

*Development of procedure for additional knock tests.*—In order to broaden the scope of the knock tests beyond that afforded by the conventional A.S.T.M. and C.F.R. research methods, considerable attention has been given to the development of a test procedure that seems better suited to the exploratory nature of this project. At the same time, it has been recognized that our present knowledge of this entire problem of technique in knock measurement is very incomplete, and will be subject to revisions in viewpoint as new concepts develop. Under these circumstances a simple, direct, and workable procedure was needed which could be expected to be a reasonably satisfactory guide to further progress in the study of fuels.

After considerable discussion of both supercharging and variable-compression methods, a decision has been reached in favor of the variable compression or critical-compression ratio technique for the present. One of the principal objections to the supercharging method is the comparatively large amount of fuel required in each test. Another problem in connection with supercharging was the question that existed as to whether the supercharging technique had yet been developed sufficiently to warrant its use in this program at this time.

*Critical-compression-ratio tests.*—The general scheme of approach that is being followed in the determination of knocking characteristics by critical-compression tests is illustrated by some data

*Fig. 5—Hydrocarbon laboratory (architect's sketch)*

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which were obtained during the course of the development of this procedure. These data are presented in Fig. 6, and include isooctane,[1] diisobutylene,[2] triptane (2,2,3-trimethylbutane),[3] and several blends of diisobutylene and benzol, respectively, in a nominal 74-octane-number base gasoline.

These data indicate clearly the exploratory nature of these combustion studies, and illustrate some of the fundamental fuel characteristics that may be expected in varying degrees among the pure hydrocarbons that will be studied in the normal course of this project. For example, the relation of the knocking tendency to changes in engine speed varies widely for different fuels. Isooctane, and the nominal 74-octane base gasoline, as well as a blend containing 75 per cent of benzol in the same gasoline, appeared to have less tendency to knock as the speed was increased from 600 r.p.m. to 2,000 r.p.m. On the other hand, diisobutylene, and even triptane—a paraffin hydrocarbon which might be expected to react like isooctane—knocked more with an increase in engine speed. All of the fuels knocked more when the operating temperature was increased, although some fuels were distinctly more sensitive to a change in operating temperature than others.

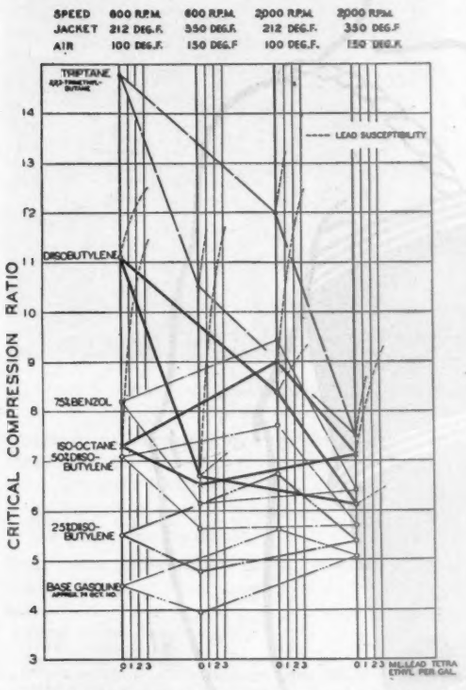



*Fig. 6—Variation in critical compression ratio of six fuels for four standard test conditions*

The net result of these varying responses to engine speed and operating temperatures is a wide variety of relative knocking characteristics that may be observed between a given group of fuels under different operating conditions. For example, under various engine operating conditions designated, the changes in relative antiknock value between isooctane, diisobutylene and a blend containing 75 per cent benzene in a nominal 74-octane-number base gasoline were as follows, in the order of decreasing degree of freedom from knock:

| Method 1 | Method 2 |
|---|---|
| Diisobutylene | Diisobutylene |
| 75 per cent benzol | Isooctane |
| Isooctane | 75 per cent benzol |
| **Method 3** | **Method 4** |
| 75 per cent benzol | Isooctane |
| Isooctane | 75 per cent benzol |
| Diisobutylene | Diisobutylene |

These variations in the relative antiknock value of three different fuels under four arbitrarily selected engine conditions, which are shown qualitatively and quantitatively in Fig. 6, indicate the complexity of the problem when it is examined in detail. This is even more apparent when it is recognized that around each point in Fig. 6, representing the characteristics of a single fuel under specified engine conditions, there can be developed an entirely new figure representing the effect of such important variables as ignition timing, mixture ratio, lead susceptibility, and of various blending materials. A partial development along these lines and pertaining to mixture ratio and lead susceptibility, of course, now is contemplated insofar as fuel supplies will permit. However, practical limitations on time and on fuel supplies will prevent the full development of knowledge of this kind on more than a very few hydrocarbons.

Further study of Fig. 6 shows the totally different order in magnitude between the effects encountered in this exploratory work and those encountered in ordinary commercial practice. For example, a change of 5 octane numbers in the range between 70 and 80 is equivalent to from 0.2 to 0.3 of a compression ratio on the scale represented in Fig. 6. This is comparatively small, if not almost negligible, in comparison with differences of from one to five compression ratios, which appear to be not uncommon between two fuels when compared in a single engine but under different operating conditions.

*Standardization of engine and test procedure for critical-compression-ratio tests.* — The foregoing tests indicated the practicability of the critical-compression-ratio method of clearly demonstrating in a general way the knocking characteristics of pure hydrocarbons over a wide range of conditions. By means of this procedure, it is possible with approximately 2,000 ml. of fuel to obtain a measure of critical compression ratio and lead susceptibility under four widely separated engine-test conditions.

The engine which has been selected for this work is a single-cylinder variable-compression valve-in-head engine, having a bore and stroke of 3¼ in. by 4½ in., respectively. This engine was built at the General Motors research laboratories for fuel research, and will operate satisfactorily at compression ratios which are continually variable between 3: 1 and 15: 1, and over a range of speeds varying between 600 and 2,000 r.p.m. Fig. 7 shows a general view of the engine and auxiliary apparatus.

The schedule of basic test conditions which have been chosen is as follows:

1. 600 r.p.m., 212° F. jacket temperature, 100° F. air, mixture strength and ignition for maximum power.

2. 600 r.p.m., 350° F. jacket temperature, 150° F. air mixture strength and ignition for maximum power.

3. 2,000 r.p.m., 212° F. jacket temperature, 100° F. air, mixture strength and ignition for maximum power.

4. 2,000 r.p.m., 350° F. jacket temperature, 150° F. air, mixture strength and ignition for maximum power.

The humidity of the air entering the engine is controlled at 100±10 grains of water vapor per pound of dry air.

The operating characteristics of the engine have been determined over the useful range of compression ratios with reference fuels. From these data it is possible to convert from critical compression ratio to per cent S-1 in M-2, or to per cent certified isooctane in *n*-heptane, or to compression pressure, or to relative power output. Complete interchangeability with other reference fuels not now in current use could be made by means of critical-compression-ratio determinations of a few blends of such reference fuels. Indicated mean effective pressures obtained from this engine under the four operating conditions enumerated previously are shown in Fig. 8.

*Comparative tests between different engines and different methods of test.*—In order to obtain some basis for the broadest possible interpretation of the critical-compression-ratio data, a series of type fuels has been compared with a common series of reference fuels in a number of different engines operated under various conditions. This comparison includes ratings by the A.S.T.M., the C.F.R. research, and C.F.R.-A.F.D. methods 1-a and 1-b, and tests in two different supercharged engines. The results are tabulated in Table 1. These data indicate that:

1. No single set of tests by the critical-compression method agrees with any one of the supercharged tests.

2. That the supercharged tests with different engines agreed when similar operating conditions were used, but under different conditions of operation the data are not comparable.

3. Only the C.F.R.-A.F.D. methods 1-a and 1-b, which do not employ supercharging, show good

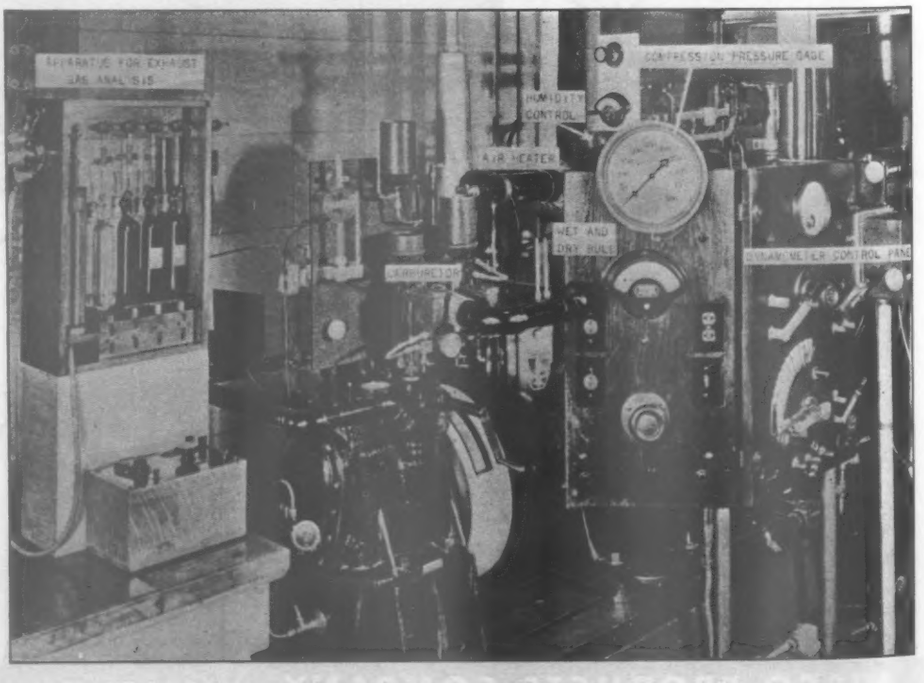



*Fig. 7—Critical-compression-ratio test engine*

[1] Reference fuel S-1; [2] Roehm and Haas; [3] sample of high purity supplied by Ethyl Gasoline Corp.

**TABLE 1—COMPARISON OF DIFFERENT TEST ENGINES**
(Ratings expressed as per cent S-1 in M-2[8])

| | From critical compression ratios[1] | | | | From supercharged engines | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2⅝-in. x 4½-in. engine[2] | | | 3¼-in. x 4½-in. engine[3] | C.F.R. research[4] | A.S.T.M.[4] | |
| Speed, r.p.m. | 600 | 600 | 2,000 | 2,000 | 600 | 900 | 1,800 | 1,800 | 600 | 900 | A.F.D.* |
| Jacket temperature, °F. | 212 | 350 | 212 | 350 | 200 | 200 | 350 | 350 | 212 | 212 | full-scale |
| Fuel— Air temperature, °F. | 100 | 150 | 100 | 150 | 110 | 110 | 110 | 110 | 100 | 300[6] | aircraft, |
| 74-octane base gasoline | 70 | 71 | 72 | 73 | 74 | 70 | 75 | 74 | 71 | 71 | |
| 74-octane gasoline plus 3.0 ml. tetraethyl lead | 87 | 90 | 94 | 93 | 90 | 89 | 91 | 92 | 88 | 88 | 90 to 92 |
| 75 per cent benzol in 74-octane base gasoline | 0.25[7] | 98 | 0.1[7] | 93 | 149[8] | 3.9[7] | 0.25[7] | 0.8[7] | 0.4[7] | 92 | 84 |
| 25 per cent diisobutylene in 74-octane base gasoline | 86 | 87 | 86 | 80 | 90 | 89 | 88 | 88 | 88 | 80 | 80 |
| 50 per cent diisobutylene in 74-octane base gasoline | 99 | 95 | 93 | 84 | 0.5[7] | 0.4[7] | 95 | 96.5 | 99 | 84 | 80 |
| Diisobutylene | 2.7[7] | 100 | 97 | 87 | 170[8] | 177[8] | 0.5[7] | 0.6[7] | 0.5[7] | 86 | |
| 50 per cent 74-octane base gasoline, 40 per cent S-1, 10 per cent isopentane, 3.0 ml. tetraethyl lead | 99 | 99 | 0.2[7] | 0.3[7] | 98 | 100 | 100 | 0.28[7] | 98 | 100 | 100 to 100+0.5 |

[1]3¼-in. x 4½-in. variable-compression engine at General Motors, research laboratories division; ignition and mixture for maximum power.
[2]Compression ratio, 5.5:1; ignition temperature, 20° b.t.c. (before true center) at 600 r.p.m., 30° at 900 and 1,800 r.p.m.; mixture for maximum thermal-plug temperature; compression-ignition piston, Ethyl Gasoline Corp.
[3]Compression ratio, 7.0:1; ignition temperature, 30° b.t.c.; mixture for maximum army-type 15-plug temperature; aluminum piston, Standard Oil Co. (Indiana).
[4]Average of ratings from two laboratories.
[5]Specifications given by C.F.R. aviation-fuels division based on the minimum ratings found in full-scale engines.
[6]300° F. mixture temperature.
[7]Milliliters of tetraethyl lead per gallon of S-1. Certified isooctane in research and A.S.T.M. procedure.
[8]Per cent boost pressure permissible with S-1.
[9]S-1 is technical isooctane having an A.S.T.M. octane number of 100; M-2 is a gasoline having an A.S.T.M. octane number of 19.
*Aviation-fuels division.

agreement with the ratings specified by the C.F.R. aviation-fuels division for correlation with full-scale engine tests.

4. The closest approach to such correlation, however, by the critical-compression-ratio tests was obtained at 2,000 r.p.m., 350° F. jacket temperature, and 150° F. air. The latter ratings were usually in fair agreement with A.S.T.M. ratings.

Although the six engine-test conditions which have been specified for use in connection with this project (A.S.T.M.) research, and four by critical compression ratio) cannot be expected to indicate the usefulness specifically for any particular type of engine, they do give a very broad survey of fuel characteristics. In addition, these data indicate that the full-scale aircraft-engine performance of specific fuels can be estimated within a reasonable degree of approximation from the critical-compression-ratio tests. At the present time it does not appear practicable to continue the supercharged tests in connection with this project because of the large amounts of fuel which would be required. However, it later may prove desirable to make supercharged tests on some particular hydrocarbons which appear especially interesting in subsequent work.

*Typical results.*—Some data which have been obtained already on certain hydrocarbons prepared at Ohio State University for use in this project are shown in Fig. 9 and in Table 2. Fig. 9, which is similar to Fig. 6, shows a wide range in relative knocking characteristics among hydrocarbons of different molecular structure and containing eight carbon atoms.

## Physical and Thermal Properties

As indicated earlier in this paper, no specific arrangements have been made for the physical and thermal-property program. Instead it is planned to make the hydrocarbons available to individuals who are specializing in the particular fields involved, and who may be in a position to cooperate in the work of the hydrocarbon project. The general plan adopted is outlined as follows:

At least 500 ml. of the best portion of each purified hydrocarbon will be set aside for the determination of physical properties. The purity of this cut will be scrutinized further; and, if advisable, additional purification will be effected by one or more appropriate methods; chemical treatment, fractional distillation, or fractional crystallization. The properties which it is desired to determine are listed hereinafter, and have been divided into two groups—in which Group 1 contains properties which probably are related to combustion characteristics fundamentally, and Group 2 contains those properties of general scientific and engineering interest which should be determined, if possible, while the pure hydrocarbons are available.

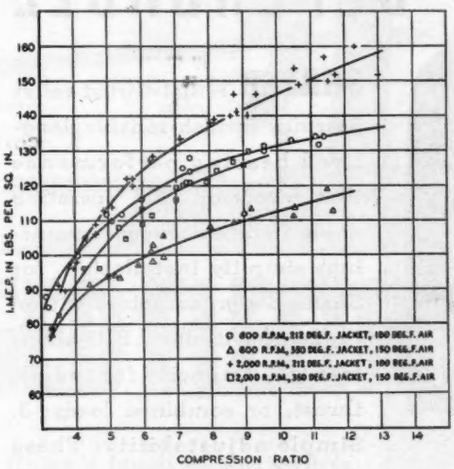

I.M.E.P. IN LBS. PER SQ. IN.
COMPRESSION RATIO
○ 600 R.P.M., 212 DEG.F. JACKET, 100 DEG.F. AIR
△ 600 R.P.M., 350 DEG.F. JACKET, 150 DEG.F.AIR
+ 2,000 R.P.M., 212 DEG.F. JACKET, 100 DEG.F.AIR
□ 2,000 R.P.M., 350 DEG.F. JACKET, 150 DEG.F.AIR

***Fig. 8—Indicated mean effective pressure vs. compression ratio for four standard conditions***

**Group 1.**

1. Heat of combustion.
2. Heat capacity down to liquid hydrogen temperatures (including determining heat of fusion).
3. Heat capacity and thermal conductivity of gaseous phase.
4. Heat of vaporization.
5. Vapor pressure.
6. Infrared absorption spectura, particularly in the range, 1 to 12μ.
7. Raman spectra.
8. Ultraviolet absorption in the Schumann region.

**Group 2.**

9. Refractive index at several temperatures.
10. Refractive dispersion at several temperatures.
11. Density at several temperatures, including 20° C.
12. Liquid viscosity at several temperatures.
13. Vapor viscosity.
14. Critical temperature of solution in aniline.

Although no hydrocarbons have been shipped for the purpose, the project has agreed to furnish materials to the following:

1. F. J. Rossini, national Bureau of Standards, for the determination of the heats of combustion.
2. Emma Carr for determination of ultraviolet absorption spectra.
3. A. V. Grosse for certain octanes to complete Raman spectra measurements.
4. H. M. Randall of the University of Michigan for infrared spectrographic studies.

The cooperation of the national Bureau of Standards has been enlisted in the determination of the heats of combustion, and probably the vapor pressure. Arrangements have been made with other departments of Ohio State University for determination of some of the other properties, and negotiations are under way with other interested parties for the balance. These determinations require only very small quantities of material, and in most cases the hydrogen is still available for other purposes after its use. It is hoped, therefore, that other qualified laboratories will express interest in securing samples of the hydrocarbons for determining other properties. Such requests will be considered carefully by the committee on the basis of the qualifications of the applicants, as well as the probable usefulness of the data to be secured. Additional properties which would seem to be of in-

**TABLE 2—SUMMARY OF KNOCK TESTS ON THREE HYDROCARBONS**

| | | | General Motors engine | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 600 r.p.m. 212° F. jacket temperature | | 600 r.p.m. 350° F. jacket temperature | | 2,000 r.p.m. 212° F. jacket temperature | | 2,000 r.p.m. 350° F. jacket temperature | |
| Hydrocarbon— | A.S.T.M. Octane No.* | Research Octane No.* | Critical compression ratio | Octane No.* | Critical compression ratio | Octane No.* | Critical compression ratio | Octane No.* | Critical compression ratio | Octane No.* |
| Ethyl cyclohexane | 40.8 | 45.6 | 3.55 | 36 | 2.80 | 32 | 4.35 | 37 | 4.00 | 45 |
| Ethyl cyclohexane plus 1.00 ml. tetraethyl lead | 52.3 | 51.3 | 3.80 | 49 | 3.00 | 47 | 4.75 | 54 | 4.25 | 55 |
| Ethyl cyclohexane plus 3.0 ml. tetraethyl lead | 65.4 | 65.4 | 4.10 | 61 | 3.45 | 62 | 5.35 | 70 | 4.75 | 69 |
| Ethyl benzene | 97.9 | †0.8 | 13.50 | ... | 8.20 | .. | 9.3 | ... | 6.9 | 97 |
| Ethyl benzene plus 1.0 ml. tetraethyl lead | 100 | †0.8 | 15.10 | ... | 9.10 | .. | 11.4 | ... | 7.8 | .. |
| Ethyl benzene plus 3.0 ml. tetraethyl lead | †0.2 | †0.8 | .... | .... | 11.00 | .. | .... | .... | 8.6 | .. |
| Isooctane (S-1) | ... | ... | 7.30 | 100 | 6.60 | 99 | 9.1 | 99.5 | 7.1 | 99 |
| Isooctane plus 1.0 ml. tetraethyl lead | ... | ... | 9.60 | ... | 8.80 | .. | 10.5 | ... | 8.0 | .. |
| Isooctane plus 3.0 ml. tetraethyl lead | ... | ... | 11.20 | ... | 11.50 | .. | 12.3 | ... | 9.1 | .. |

*Equivalent per cent isooctane in *n*-heptane for each corresponding engine condition.
†Milliliters of tetraethyl lead in certified isooctane.

terest are dielectric constants, dipole moments, surface tensions, PVT (pressure-volume-temperature) relationships, etc.

### Conclusion

In conclusion, it is pointed out that the A.P.I. hydrocarbon research project has been formed to make as complete a study as possible of the engine-combustion, physical and thermal properties of the gasoline-range hydrocarbons. A laboratory organization has been established at Ohio State University to prepare the required hydrocarbons; the research laboratories of the General Motors Corp. have undertaken the engine research program; and plans have been formulated to make materials available to appropriate specialists for physical and thermal-property determinations. The project now is entering upon the second year of an anticipated 4-year program. A number of hydrocarbons have been procured or prepared, and subjected to the examination in the basic engine program. The engine-study procedure has been explored thoroughly; and, as finally adopted for the project, is shown to cover a very wide range of engine conditions, and to be capable of producing results which are indicative of basic knocking tendencies. This work is proceeding as rapidly as the hydrocarbons become available.

The purpose of this report is to outline the objectives and procedures employed by the A.P.I. hydrocarbon research project. With its submission, the duties of the chairman with regard to presentation of the work of the project may be considered as largely fulfilled. It is anticipated that future reports will present specific data, and will be presented by the individuals most closely concerned.

### Appendix 1

**COMMITTEE ON HYDROCARBON RESEARCH**

Chairman: D. P. Barnard, Standard Oil Co. (Indiana), Whiting, Ind.

E. G. Borden, Power Patents Co., New York.

R. E. Burk, Standard Oil Co. of Ohio, Cleveland, Ohio.

*G. H. Burruss, Anderson-Prichard Oil Corp., Oklahoma City, Okla.

George Calingaert, Ethyl Gasoline Corp., Detroit, Mich.

*B. P. Crittenden, Rodessa Oil & Refining Co., Shreveport, La.

D. E. Day, Richfield Oil Co., Los Angeles, Calif.

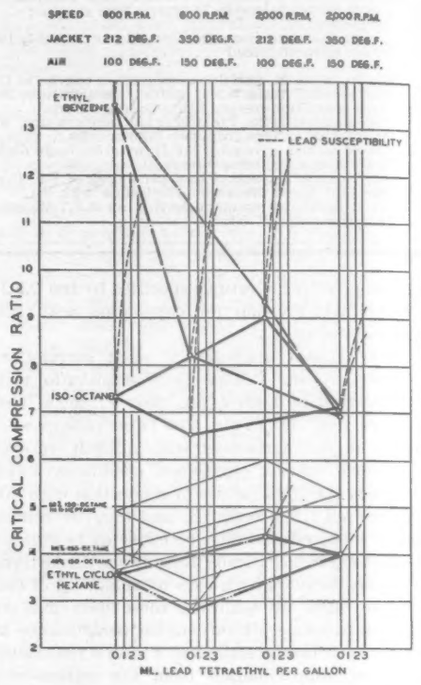

SPEED 600 R.P.M. 600 R.P.M. 2000 R.P.M. 2000 R.P.M.
JACKET 212 DEG.F. 350 DEG.F. 212 DEG.F. 350 DEG.F.
AIR 100 DEG.F. 150 DEG.F. 100 DEG.F. 150 DEG.F.
ETHYL BENZENE
LEAD SUSCEPTIBILITY
ISO-OCTANE
ETHYL CYCLO HEXANE
CRITICAL COMPRESSION RATIO
ML. LEAD TETRAETHYL PER GALLON

*Fig. 9—Variation in critical compression ratio, for four standard test conditions, for ethyl benzene, ethyl cyclohexane, and isooctane (2,2,4-trimethylpentane)*

Gustav Egloff, Universal Oil Products Co., Chicago, Ill.

S. W. Ferris, Atlantic Refining Co., Philadelphia, Pa.

E. W. Gard, Union Oil Co. of California, Los Angeles, Calif.

J. M. Gardiner, Republic Oil Co., Pittsburgh, Pa.

R. A. Halloran, Standard Oil Co. of California, San Francisco, Calif.

J. Bennett Hill, Sun Oil Co., Philadelphia, Pa.

W. E. Kuhn. Texas Co., New York.

*B. H. Lincoln, Continental Oil Co., Ponca City, Okla.

W. G. Lovell, General Motors Corp., Detroit, Mich.

†J. T. McCoy, Tide Water Associated Oil Co., Bayonne, N. J.

J. B. Macauley, Chrysler Corp., Detroit, Mich.

A. E. Miller, Sinclair Refining Co., New York.

C. W. Montgomery, Gulf Research & Development Co., Pittsburgh, Pa.

*W. E. Moody, Deep Rock Oil Corp., Cushing, Okla.

E. V. Murphree, Standard Oil Development Co., New York.

†G. G. Oberfell, Phillips Petroleum Co., Bartlesville, Okla.

†J. T. Poole, Lion Oil Refining Co., El Dorado, Ark.

J. B. Rather, Socony-Vacuum Oil Co., Inc., New York.

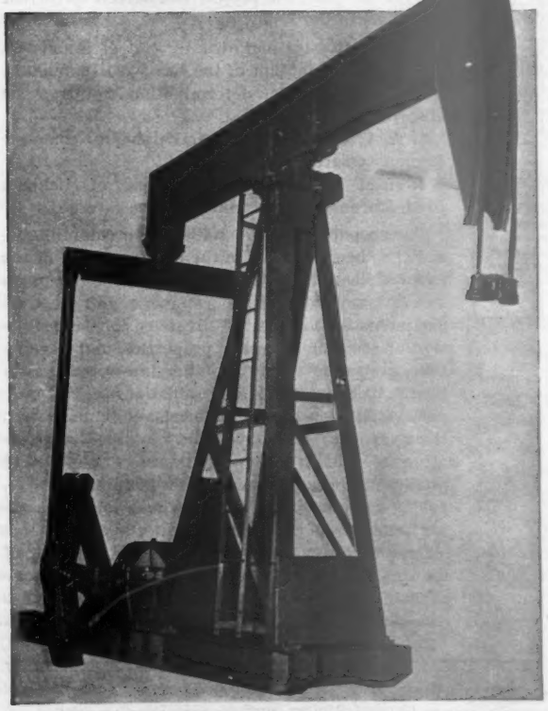
H. V. Smith, Barber Co., Philadelphia, Pa.

S. Tijmstra, Shell Development Co., Emeryville, Calif.

C. R. Wagner, Pure Oil Co., Chicago, Ill.

*First year. †Second year.

COMPACT AND DEPENDABLE



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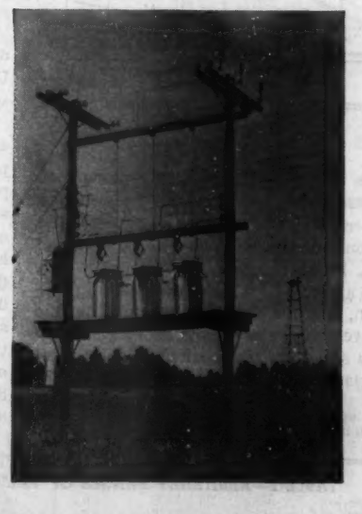

*A typical scene showing one of 27 wells in one field alone which are pumped by Purchased Electric Power. These wells are located in Upshur County, East Texas.*

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# A Comparison of Methods for Estimating Soil Corrosivity

By K. H. LOGAN
National Bureau of Standards, Washington, D. C.*

and E. A. KOENIG
Magnolia Pipe Line Co., Dallas, Tex.

A. P. I. — Presented before annual meeting, Chicago, Ill., November 13-17, 1939

IN 1937 the Magnolia Pipe Line Co. exposed approximately 25 miles of an 8-in. asphalt-coated steel line in southeastern Texas; measured the depth of the deepest three pits on each joint of pipe; and estimated the condition of each joint. The resistivity of the soil at pipe depth was determined at approximately 200-ft. intervals. The soils along the right-of-way were mapped, by R. L. Phillips, according to methods established by the U. S. Department of Agriculture. Phillips described the soils, and took approximately 250 samples of soil at pipe depth. A part of each sample was tested in the field, and another part was forwarded to the National Bureau of Standards for further investigation. In this paper the results of tests of these samples are compared with pit depths which are taken as the measure of the corrosiveness of the soils.

### Criteria for Soil Corrosivity

For the purposes of this paper corrosivity may be defined as the power to impair the usefulness of a pipe through chemical, electrochemical, or biochemical processes. This definition implies that the extent to which a pipe is damaged by corrosion depends not only on the amount of metal removed, but on the distribution of the loss. The significance

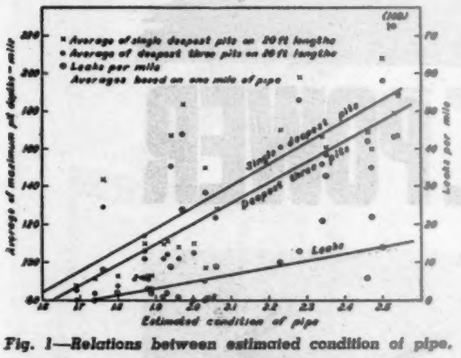
Average of single deepest pits on 20 ft lengths
Average of deepest three pits on 20 ft lengths
Leaks per mile
Averages based on one mile of pipe
Single deepest pits
Deepest three pits
Leaks
Average of maximum pit depths - mils
Leaks per mile
Estimated condition of pipe

*Fig. 1—Relations between estimated condition of pipe, leaks, and pit depths*

or importance of pit depths depends not only on the area, depth, and position of the pits with respect to other pits, but also on whether their depths will continue to increase and on the rate of that increase. From a practical point of view, the usefulness of a pipe depends not only on its physical condition, but on the cost of stopping the corrosion or restoring the pipe to its original usefulness. This situation has resulted in the use of several criteria for classifying pipe and, hence, for line or some major part thereof, rather than the defining the corrosiveness of soils in terms of their effects on pipes. Among these criteria may be mentioned the annual cost of keeping a pipe line in operation, the frequency of the occurrence of leaks, estimates of the condition of the pipe based in whole or in part on the judgment of some qualified inspector, the depth of the deepest pit on some unit length or area of pipe, and the averages of the depths of several or all the pits on the unit inspected. In most cases it is the condition of the condition of a single joint, that is desired.

All these criteria for the condition of a pipe except the first two fail to take into account the effect of time on the rate of corrosion, although it has been shown[1, 2, 3] that rates of corrosion are different for different soils and for different periods of exposure, and that a pipe which has corroded less than a nearby pipe after one period of exposure may have corroded more than the second pipe at a later period.

The papers referred to show also that the pit depth-area relation is not the same for all soils. Usually this fact also is ignored in determining soil corrosivity.

Maintenance records have not been considered as criteria for soil corrosiveness in this paper—partly because they were not readily available, but principally because such records are usually unsatisfactory criteria for the relative corrosiveness of short sections of line. All of the other criteria have been given some consideration. Fig. 1 shows that there is a rough correlation between the condition of the sections of the line as they were classified by an inspector and three other criteria for the condition of the sections. The figure is based on the average condition of mile sections of the line as determined from the conditions of the individual joints within the mile. The subdivision of the line into much shorter lengths would have resulted in a considerable number of sections having no leaks and, hence, in an apparently perfect condition—although some of them would have contained pits the depths of which were within a few thousandths of an inch of the thickness of the pipe wall. Because of this condition, leaks were not regarded as a satisfactory criterion for the corrosiveness of the soils under consideration, although Ewing[4] and Denison[4] have found them quite satisfactory in the study of a longer pipe line.

When the pipe was inspected, each joint was put into one of the four following classes: Class No. 1—no repairs, no pits deeper than 120 mils; No. 2—not over 25 spot welds required, pit depths between 70 and 260 mils; No. 3—pipe required not more than 40 spot welds, and ranged with respect to pit depths from 40 mils to not more than 3 punctures; Class No. 4—consisted of junk pipe, although the deepest pit on one joint was not over 180 mils. It will be noted that, with respect to maximum pit depths, these classes overlapped considerably. A joint of pipe having a maximum pit depth equal to 0.8 of the wall thickness of the pipe, according to its general condition, might be placed in any one of three classes.

With respect to one or two methods of testing soil corrosiveness, the estimated condition of the pipe was tried as the criterion for the corrosivity of the soil, but estimated condition was abandoned as a criterion because it did not appear to be as sensitive as some others. The result of one of these trials will be shown later.

Pit depths appeared to be the most sensitive and the most nearly-reproducible measure of corrosion.

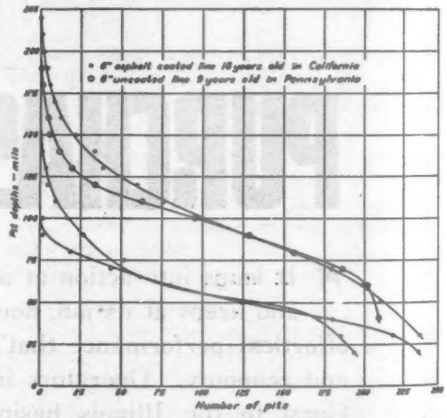
6" asphalt coated line 18 years old in California
6" uncoated line 9 years old in Pennsylvania
Pit depths - mils
Number of pits

*Fig. 2—Cumulative pit depth-frequency curves for four 19-ft. joints of pipe*

*Publication approved by the director of the National Bureau of Standards, Washington, D. C.

TABLE 1—ARBITRARY RANGES OF VALUES OF DATA FOR SOILS IN DIFFERENT CLASSES WITH RESPECT TO THEIR CORROSIVITY

| Soil-corrosivity group | Pit depth (mils) | Shepard resistivity meter (ohm-centimeters) | Resistivity at moisture equivalent (ohm-centimeters) | Total acidity (milligram equivalents per 100 grams of soil) | Acidity times 1,000 / resistivity | Modified Columbia rod test (milli-amperes) | Putnam test (milli-amperes) | Nipple-and-can test (grams) | Denison electrolytic cell (milli-amperes per square decimeter) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 100 | 5,000 | 10,000 | 4.0 | 1.5 | 1.75 | 3.75 | 0.30 | 3.0 |
| 2 | 101-125 | 2,000-4,999 | 5,000-9,999 | 4.1- 8.0 | 1.6-3.0 | 1.76-2.50 | 3.76- 5.00 | 0.31-0.35 | 3.1- 6.0 |
| 3 | 126-150 | 1,000-1,999 | 2,000-4,999 | 8.1-12.0 | 3.1-4.5 | 2.51-3.05 | 5.01-10.00 | 0.36-0.40 | 6.1- 9.0 |
| 4 | 151-200 | 700- 999 | 1,000-1,999 | 12.1-16.0 | 4.6-6.0 | 3.01-4.0 | 10.01-15.00 | 0.41-0.80 | 9.1-15.0 |
| 5 | 200 | 700 | 1,000 | 16.0 | 6.0 | 4.00 | 15.00 | 0.80 | 15.0 |

Studies of the data showed that they might be used in several ways—each of which had certain advantages over the others. One of these ways was to consider only the deepest pit on the joint of

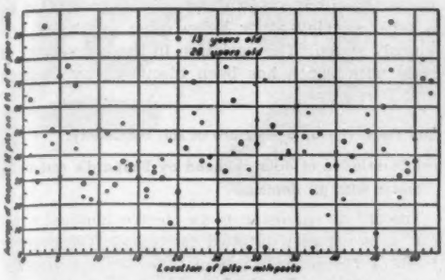


*Fig. 3—Averages of the deepest 12 pits on each of two parallel pipe lines. (The observations were made at points 1 mile apart.)*

pipe nearest the point where the sample of soil was taken. This method involves less chance of error due to variations in the character of the soil; but bases the corrosivity of the soil sample on the depth of a single pit, the depth of which might be accidental. Another objection to this procedure is that the pit, the depth of which was used as a measure of the corrosiveness of the soil, might have been several feet from the point where the sample was taken, and much deeper than the pit nearest the soil sample. A second method, the use of the deepest pit on each of 10 joints of pipe nearest the sampling point, did not change greatly the apparent merits of the tests in which this criterion also was used, as will be demonstrated later.

A third method of using maximum pit depths would be to consider the deepest pit on each joint of pipe associated with a sample of soil. The justification for this method is the assurance of the soil surveyor that each sample of soil was representative of the soil between the point where it was obtained and the point where the next sample was taken. However, as this distance varied from 20 ft. to 5,000 ft., the reliability of the averages as indicated would vary greatly. The experience of Scott[5] and others has shown that it is often difficult to find as much as 1,000 ft. of pipe line along which the soil is uniform in its properties.

Data are available also which would permit the use of the deepest three pits instead of the deepest pit in each of the above methods. After some study of these criteria, it was decided that none offered a preponderant advantage over the maximum pit on the joint of pipe adjacent to the point where the soil sample was taken; and the calculations in the next section of this paper, therefore, were made with this as the criterion for the corrosiveness of the soil sample. In a later part of the paper use will be made of other pit depths also.

That the several criteria for soil corrosivity give similar results is suggested by Fig. 2, which was constructed from data furnished by J. M. Pearson of the Susquehanna Pipe Line Co. and F. D. Posey of the General Petroleum Corp. The figure shows cumulative pit-depth-frequency curves for three 19-ft. joints of an asphalt-coated line and one 19-ft. joint of an unprotected line. All curves have much the same shape, and show a few relatively deep pits and many pits of nearly the same depth. Insofar as this relation between pit depths is general, the relative corrosiveness of soils based on the deepest pit would be about the same as that based on several pits or on the condition of the pipe. Although it is possible that many lengths of pipe could be found that would yield different frequency-distribution curves, those shown in Fig. 2 probably are more common, as is evidenced by the fact that for the 25-mile line the different ways of considering pit depths yielded similar results. This will be shown by figures presented later. That there is a relation between the depth of the deepest pit on an area and the depths of the other pits was shown by Ewing,[6] who showed

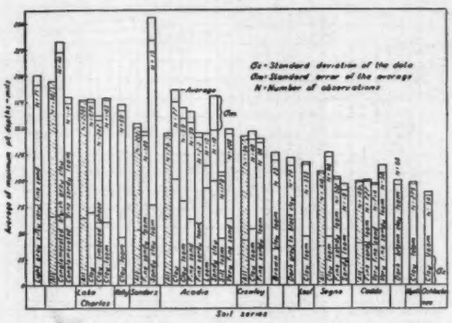


*Fig. 4—Average depths of the deepest pit on each joint in the various soils*

that the number of pits of a given depth on any area can be calculated from the depth of the deepest pit on any other area if the pit depth-area relation is known. Of course, the results of such calculations are applicable in a statistical sense only, i. e., to the average of a large number of observations—not to the number of pits on a single section of pipe. Hence we are reasonably sure that we have an accurate measure of the corrosion which occurred on this line, but this should not be taken to mean that we have an equally reliable measure of the corrosiveness of the soils along the line—which fact we now shall discuss further.

It has been observed frequently that two pipe lines exposed to apparently identical conditions corrode at different rates. This is illustrated by Fig. 3, plotted from data furnished by W. F. Rogers of the Gulf Companies on two bare, parallel 8-in. lines. Each point represents the average of the depths of the deepest 12 pits on 4 ft. of pipe. Inasmuch as at many points of observation the average of the pit depths on the 28-year-old line is less than that for the line half as old, it is evident that the older line corroded at the lower rate. Several explanations of this common condition could be offered, but all of them lead to the conclusion that the depths of the pits on a pipe line may be determined by causes other than the corrosivity of the soil to which the corroding section of pipe is exposed. To the extent to which this is significant, no test of a sample of soil will show the extent of the corrosion which may occur on a pipe line laid in that soil.

## Comparison of the Results of Soil Examinations With the Corrosion on the Pipe

Inasmuch as many methods and pieces of apparatus for ascertaining the corrosivity of soils have been described in detail in two recent books,[7, 8] only the essentials of the tests which are to be compared and the modifications made in them will be noted here. There are, in addition, several other methods for determining the corrosiveness of soils, and several other pieces of apparatus that can be used with the methods investigated, which have not been considered because of lack of time and materials rather than because they were considered less valuable.

**The use of soil classification in corrosion surveys.**

For many years the U. S. Department of Agriculture has been engaged in a survey of the soils of the United States. Between a third and a half of the country has been mapped. A soil type is a soil unit based on uniformity of all soil characteristics, and is designated by the series name and a texture description. All soil units in which all soil characteristics except the texture of the surface horizon are uniform are grouped into a series. For example, in Norfolk sandy loam the textural designation refers to the surface layer or horizon, and the name Norfolk refers to the series.

It is reasonable to suppose that all soil suffi-

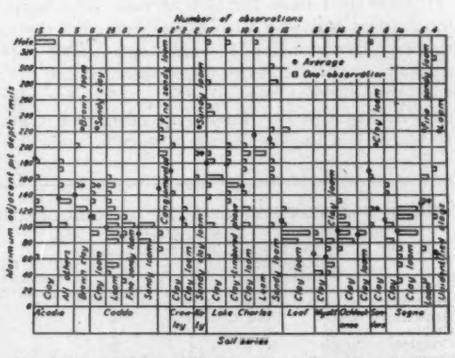


*Fig. 5—Distribution of the depths of the deepest pit on the joint of pipe adjacent to a soil sample in the various soils*

**TABLE 2—SUMMARY OF DATA TO BE CORRELATED**

| Soil series— | Pipe-line data: Averages of depth of deepest pit on 20-ft. sections of pipe: Adjacent soil sample (mils) | In soil series (mils) | Number of samples tested | Number of pipe lengths | Per cent of total line | Averages of results of corrosivity tests: Shepard resistivity meter (ohm centimeters) | Resistivity at moisture equivalent (ohm-centimeters) | Saturated resistivity (ohm-centimeters) | Total acidity (milligram equivalents per 100 g. of soil) | Acidity times 1,000 / Resistivity | Modified Columbia rod test (milliamperes) | Putnam test (milliamperes) | Nipple-and-can test (grams) | Denison electrolytic cell (milliamperes per square decimeter) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acadia | 189 | 145 | 14 | 791 | 12.91 | 1,634 | 2,210 | 2,370 | 14.09 | 5.95 | 3.33 | 6.48 | 0.554 | 8.18 |
| Brown | 142 | 126 | 5 | 23 | 0.38 | 745 | 790 | 1,130 | 2.16 | 1.91 | 2.77 | 10.29 | 0.389 | 6.68 |
| Caddo | 96 | 99 | 38 | 1,491 | 24.43 | 12,625 | 37,940 | 23,460 | 4.28 | 0.18 | 0.47 | 1.70 | 0.126 | 0.99 |
| Conglomerate | 148 | 195 | 4 | 158 | 2.59 | 2,013 | 1,530 | 1,720 | 1.90 | 1.10 | 1.29 | 5.44 | 0.587 | 12.95 |
| Crowley | 140 | 142 | 4 | 134 | 2.20 | 3,200 | 1,830 | 2,650 | 10.22 | 3.86 | 2.15 | 4.35 | 0.256 | 7.95 |
| Dark brown | 60 | 99 | 1 | 60 | 0.98 | 8,000 | 2,600 | 3,470 | 1.90 | 0.55 | 1.64 | 3.55 | 0.307 | 0.00 |
| Lake Charles | 80 | 177 | 26 | 2,095 | 34.32 | 1,846 | 980 | 1,250 | 9.43 | 7.54 | 3.74 | 10.11 | 0.337 | 10.51 |
| Leaf | 110 | 117 | 12 | 533 | 8.73 | 2,525 | 2,050 | 3,460 | 16.45 | 4.75 | 1.76 | 4.93 | 0.330 | 4.64 |
| Light gray | 240 | 201 | 2 | 71 | 1.16 | 700 | 270 | 380 | 2.00 | 5.26 | 4.87 | 26.65 | 0.842 | 35.0 |
| Myatt | 71 | 97 | 10 | 275 | 4.51 | 1,520 | 940 | 1,480 | 2.84 | 1.92 | 1.87 | 7.55 | 0.266 | 7.89 |
| Ochlockonee | 93 | 88 | 15 | 54 | 0.88 | 7,091 | 5,290 | 6,270 | 15.48 | 2.47 | 0.96 | 2.43 | 0.273 | 0.89 |
| Segno | 97 | 108 | 31 | 418 | 6.85 | 2,553 | 2,800 | 3,940 | 5.27 | 1.34 | 1.55 | 4.91 | 0.354 | 4.83 |

ciently uniform to be classed as one type, or possibly as a whole series, would have a characteristic corrosiveness.

Fig. 4 shows the averages of the depths of the deepest pit on each joint of the pipe in each soil type and in each series. The figures in each column show the number of pit depths averaged. This is equal to the number of joints of pipe exposed to the soil unit. The standard deviation shown at the bottom of each column indicates roughly the dispersion of the data, whereas the standard error of the average at the top of the column shows its reproducibility and forms a basis for determining the probability that two averages are significantly

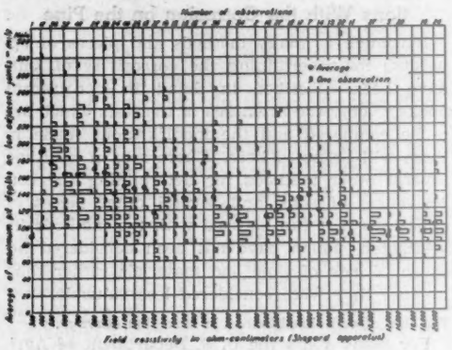

*Fig. 6—Relation between readings obtained with Shepard's resistivity meter and averages of the depths of the deepest pit on each of the 10 joints of pipe nearest the point where the soil resistivity was measured*

different. The soil series have been arranged in order of the averages of the pit depths with the greatest mean depth on the left. Within the series, the soil types have been arranged according to the texture of the A horizon, i. e., the surface layer of the soil, with the heaviest texture at the left of the group.

It is evident from Fig. 4 that some soils were much more corrosive than others, although their standard deviations show wide dispersion of the data. In certain soil series the probability that the soil types differ in corrosiveness is high, but the data in Fig. 4 do not justify the conclusion that corrosion is a function of the texture of the soil; because the texture of the A horizon, which determines the soil type, may be quite different from that surrounding the pipe or that below the pipe. In the Acadia and Lake Charles series all of the soil types are underlain by a heavy layer of clay which controls the drainage of the soil surrounding the pipe and, consequently, the rate of corrosion. On this account the test data for the Acadia and Lake Charles series, other than data for the clays, were discarded, because the soil samples were not representative of the material that was responsible for the corrosion.

Because this condition exists in several soil series, it is important in making soil surveys to take the sample of soil from the heaviest soil horizon rather than from the horizon in which the pipe will lie.

The correlation between soil texture at pipe depth and the deepest pit adjacent to the soil sample is shown in Fig. 5. The names near the top of the figure show the texture of the soil sample taken at pipe depth as determined by mechanical

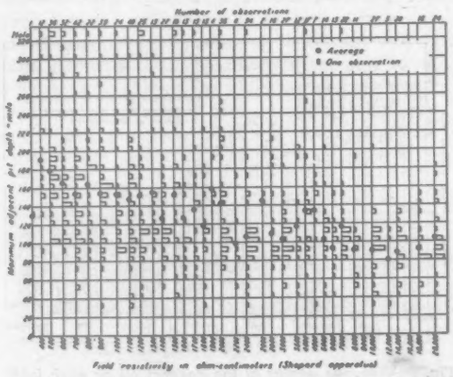

*Fig. 7—Relation between readings obtained with Shepard's resistivity meter and the deepest pit on the joint of pipe adjacent to the point where the soil resistivity was measured*

analysis. In many instances they are not necessarily the names of the soil types as classified in the field. The lengths of the horizontal columns indicate the number of pit depths for a given set of conditions. The average of the pit depths in one texture of a soil is represented by a dot. These averages indicate in a general way that in most soils the corrosivity of the soil within a series decreases as the texture becomes lighter. This does not hold for the Acadia and Lake Charles soils, because the corrosion in these soils is controlled by a layer of clay at or below pipe depth, as previously stated. The variation in the corrosivity of soils with depth has been discussed by Denison and Darnielle.[4]

**Soil resistivity as a measure of soil corrosivity.**

**(a) Correlation of data obtained by Shepard's resistivity meter with pit depths.**

Insofar as corrosion is an electrochemical process, it is affected by two factors: 1, the driving force or difference of potential between anodic and cathodic areas; and, 2, the forces opposing this tendency. The opposing forces are chiefly the electrical resistance of the electrolyte and the counter-electromotive force, commonly known as polarization. One or another of these factors may control the rate of corrosion. The presence of soluble salts is indicated by low resistivity of the electrolyte or soil solution. This probably accounts, indirectly at least, for the development of simple tests for soil corrosivity based only on the measurement of the resistivity of the soil.

Of the many pieces of apparatus with which such a measurement can be made, Shepard's resistivity meter[5] is perhaps the simplest and most frequently used. Two steel-tipped rods are thrust into the soil 6 in. or more apart, and the current which a three-volt battery caused to pass between them is measured by a milliammeter calibrated to read resistivity in ohm-centimeters. To minimize polarization, which usually affects direct-current measurements of the resistance of an electrolyte, the cone connected to the negative side of the battery is made much larger than the other one. This design was based on the experience that in most soils most of the polarization occurred at the cathode.

Measurements were made by means of the resistivity meter at intervals of 200 ft. or 10 lengths of pipe. The correlation between these data and the averages of the deepest pit on each of the 10 lengths nearest the test points is shown in Fig. 6. The method used in Fig. 6 and the following figures makes the use of a uniform scale for the abscissae impracticable. Fig. 6 is similar to those

**TABLE 3—ASSIGNMENT OF DATA TO SOIL-CORROSIVITY GROUPS AS INDICATED BY TABLES 1 AND 2**

| Soil series— | Grouping by adjacent maximum pit depth | Grouping by average of all pits in soil series | Shepard resistivity meter | Resistivity at moisture equivalent | Acidity times 1,000 Total acidity | Acidity times 1,000 Resistivity | Modified Columbia rod test | Putnam test | Nipple-and-can test | Denison electrolytic cell |
|---|---|---|---|---|---|---|---|---|---|---|
| Acadia | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 4 | 3 |
| Brown | 3 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 3 | 3 |
| Caddo | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 |
| Conglomerate | 3 | 4 | 2 | 4 | 1 | 1 | 1 | 3 | 4 | 4 |
| Crowley | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 3 |
| Dark brown | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 |
| Lake Charles | 4 | 4 | 3 | 5 | 3 | 5 | 4 | 4 | 2 | 4 |
| Leaf | 2 | 2 | 2 | 3 | 5 | 4 | 2 | 2 | 2 | 2 |
| Light gray | 5 | 5 | 4 | 5 | 1 | 4 | 5 | 5 | 5 | 5 |
| Myatt | 1 | 1 | 3 | 5 | 1 | 2 | 2 | 3 | 1 | 3 |
| Ochlockonee | 1 | 1 | 1 | 2 | 4 | 2 | 1 | 1 | 1 | 1 |
| Segno | 1 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 |

**TABLE 4—COMPARISON OF TEST METHODS ON THE BASIS OF AVERAGES OF THE MAXIMUM PIT ON THE JOINT ADJACENT TO THE SOIL SAMPLE**

| Soil series— | Per cent of line | Shepard resistivity meter | Resistivity at moisture equivalent | Acidity times 1,000 Total acidity | Acidity times 1,000 Resistivity | Modified Columbia rod test | Putnam test | Nipple-and-can test | Denison electrolytic cell |
|---|---|---|---|---|---|---|---|---|---|
| DEPARTURE FROM CORRECT ASSIGNMENT | | | | | | | | | |
| Acadia | 12.96 | −1 | −1 | 0 | 0 | 0 | −1 | 0 | −1 |
| Brown | 0.38 | +1 | +2 | −2 | −1 | 0 | +1 | 0 | 0 |
| Caddo | 24.43 | 0 | 0 | +1 | 0 | 0 | 0 | 0 | 0 |
| Conglomerate | 2.59 | −1 | +1 | −2 | −2 | −2 | 0 | +1 | +1 |
| Crowley | 2.20 | −1 | +1 | 0 | 0 | −1 | −1 | −2 | 0 |
| Dark brown | 0.98 | 0 | +2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lake Charles | 34.32 | −1 | +1 | −1 | +1 | 0 | 0 | −2 | 0 |
| Leaf | 8.73 | 0 | +1 | +3 | +2 | 0 | 0 | 0 | 0 |
| Light grey | 1.16 | 0 | 0 | −4 | −1 | 0 | 0 | 0 | 0 |
| Myatt | 4.51 | +2 | +4 | 0 | +1 | +1 | +2 | 0 | +2 |
| Ochlockonee | 0.88 | 0 | +1 | +3 | +1 | 0 | 0 | 0 | 0 |
| Segno | 6.85 | +1 | +2 | +1 | 0 | 0 | +1 | +1 | +1 |
| PERCENTAGES OF CORRECT ASSIGNMENT | | | | | | | | | |
| Per cent of soils | | 42 | 17 | 33 | 42 | 75 | 58 | 67 | 67 |
| Per cent of line | | 36 | 26 | 21 | 47 | 91 | 73 | 54 | 73 |
| PERCENTAGES WITH AN ERROR OF NOT MORE THAN ONE CORROSION GROUP | | | | | | | | | |
| Per cent of soils | | 92 | 67 | 58 | 83 | 92 | 92 | 83 | 92 |
| Per cent of line | | 95 | 87 | 86 | 89 | 97 | 95 | 65 | 95 |

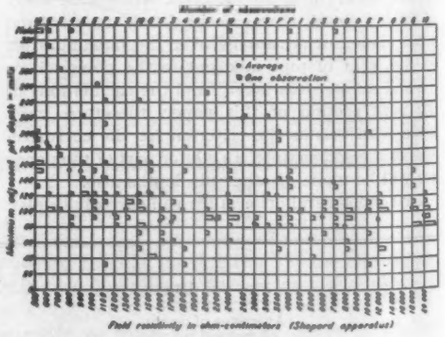

*Fig. 8—Relation between readings obtained with Shepard's resistivity meter and the deepest pit on the joint nearest the point where a soil sample was taken*

of Weidner and Davis[10] in their more extensive report on the correlation of field resistivity with pit depths.

As in Fig. 5 and most of the figures to follow, the horizontal length of each rectangle is proportional to the number of pits represented, and the dots represent the average pit depths. It will be seen that a wide range of pit depths is associated with each soil resistivity. However, the averages of the pit depths associated with each value of soil

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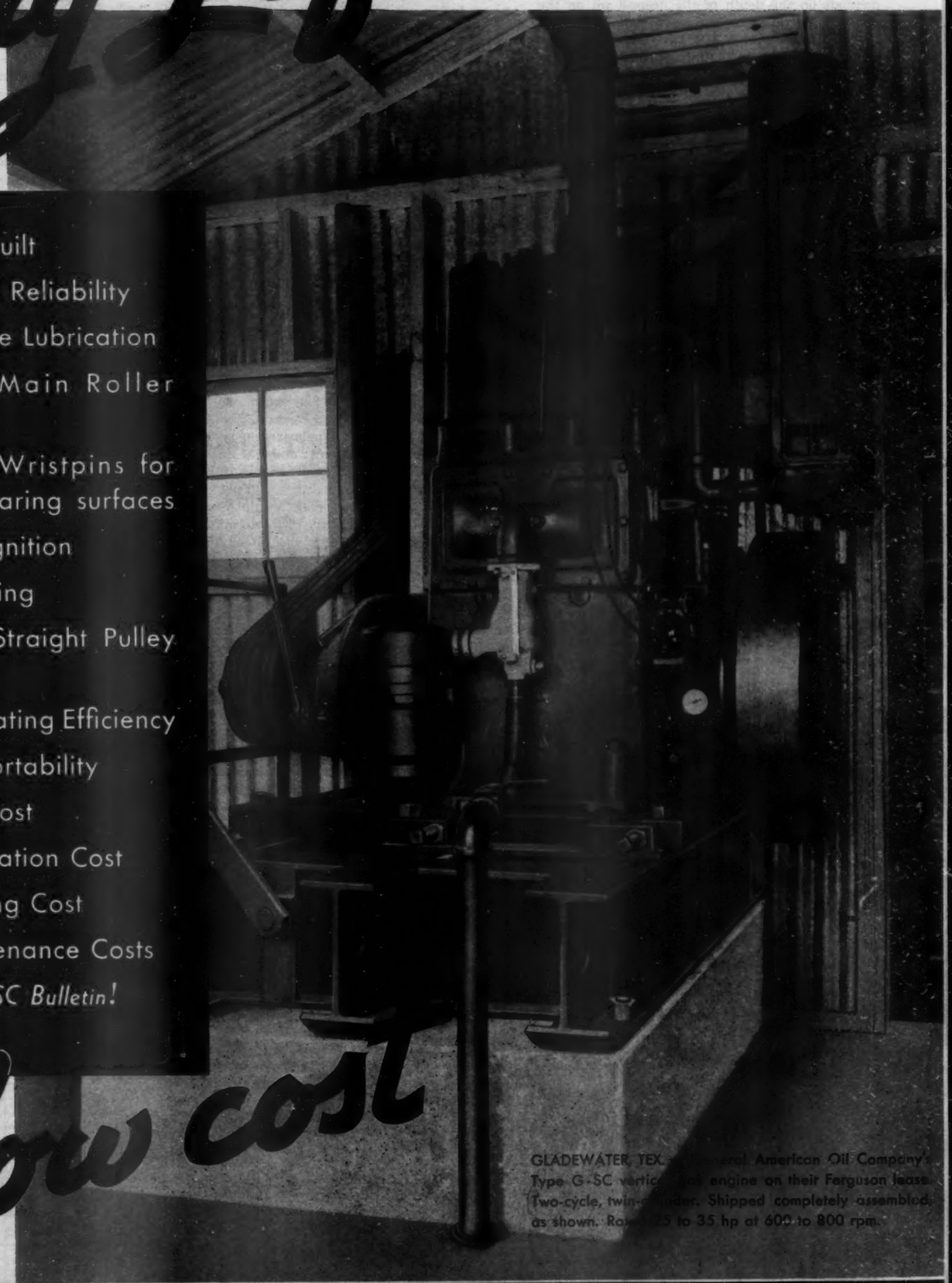

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resistivity tend to fall along a line which indicates that the average pit depth increases as the soil resistivity decreases.

As it was decided to base the comparison of test methods on the depth of the deepest pit on the joint of pipe adjacent to the soil sample, the rectangles and dots of Fig. 7 have been plotted to show the correlation of this measure of soil corrosivity with soil resistivity. Fig. 7 is similar to Fig. 6; but shows a wider range of values, because it is based on single observations, whereas the rectangles in Fig. 6 are based on averages of 10 pits.

Figs. 6 and 7 represent approximately 600 associated values of pit depths and resistivity measurements, whereas most of the figures which are to follow are based on approximately 160 associated values of pit depths and results of soil tests. Consequently, in order to compare resistivity tests with the others on the basis of equal numbers of trials, only those resistivities which were measured at the points where soil samples were taken were used for correlation with pit depths on the adjacent pipe. This correlation is shown in Fig. 8.

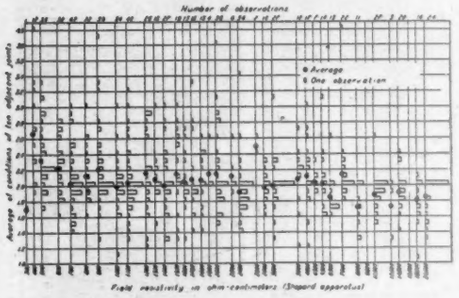

*Fig. 9—Relation between readings obtained with Shepard's resistivity meter and the averages of the conditions of the 10 joints of pipe nearest the point where the resistivity was measured (compare with Fig. 6)*

wherein the dots represent the averages of the pit depths. The chief result of the reduced number of observations is a less well-defined trend of the data.

**(b) Correlation of Shepard soil-resistivity measurements with estimates of pipe condition.**

Figs. 9 and 10 have been constructed to illustrate the effects of using estimates of the condition of sections of the line as the measure of soil corrosivity. The method of determining the condition of the pipe has been given. Fig. 9 is comparable with Fig. 6 and Fig. 10 with Fig. 7. Although Figs. 9 and 10 show, in a general way, that the resistivity of soils increases with decreasing corrosiveness as indicated by the estimated condition of the pipe, these estimates seem to be a less-sensitive measure of corrosion, and this criterion was not applied to other tests of corrosivity.

**TABLE 5—COMPARISON OF TEST METHODS ON THE BASIS OF AVERAGES OF THE MAXIMUM PIT ON EACH JOINT OF PIPE IN A SOIL SERIES**

| Soil series— | Per cent of line | Shepard resistivity meter | Resistivity at moisture equivalent | Acidity times 1,000 / Total acidity | Acidity times 1,000 / Resistivity | Modified Columbia rod test | Putnam test | Nipple-and-can test | Denison electrolytic cell |
|---|---|---|---|---|---|---|---|---|---|
| | | DEPARTURE FROM CORRECT ASSIGNMENT | | | | | | | |
| Acadia | 12.96 | 0 | 0 | +1 | +1 | +1 | 0 | +1 | 0 |
| Brown | 0.38 | +1 | +2 | −2 | −1 | 0 | +1 | 0 | 0 |
| Caddo | 24.43 | 0 | 0 | +1 | 0 | 0 | 0 | 0 | 0 |
| Conglomerate | 2.59 | −2 | 0 | −3 | −3 | −3 | −1 | 0 | 0 |
| Crowley | 2.20 | −1 | +1 | 0 | 0 | −1 | −1 | −2 | 0 |
| Dark brown | 0.98 | 0 | +2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lake Charles | 34.32 | −1 | +1 | −1 | +1 | 0 | 0 | −2 | 0 |
| Leaf | 8.73 | 0 | +1 | +3 | +2 | 0 | 0 | 0 | 0 |
| Light gray | 1.16 | 0 | 0 | −4 | −1 | 0 | 0 | 0 | 0 |
| Myatt | 4.51 | +2 | +4 | 0 | +1 | +1 | +2 | 0 | +2 |
| Ochlockonee | 0.88 | 0 | +1 | +3 | +1 | 0 | 0 | 0 | 0 |
| Segno | 6.85 | 0 | +1 | 0 | −1 | −1 | 0 | 0 | 0 |
| | | PERCENTAGES OF CORRECT ASSIGNMENT | | | | | | | |
| Per cent of soils | | 58 | 33 | 33 | 25 | 58 | 67 | 75 | 92 |
| Per cent of line | | 56 | 41 | 15 | 28 | 71 | 90 | 51 | 95 |
| | | PERCENTAGES WITH AN ERROR OF NOT MORE THAN ONE CORROSION GRO | | | | | | | |
| Per cent of soils | | 83 | 75 | 58 | 83 | 92 | 92 | 83 | 92 |
| Per cent of line | | 93 | 94 | 86 | 89 | 97 | 95 | 63 | 95 |

**Correlation of soil resistivity at moisture equivalent with maximum pit depths.**

Three possible sources of error might account for the imperfect correlation between the soil resistivity as measured by Shepard's resistivity meter and corrosion: (1) poor contact between the electrodes and the soil; (2) polarization resulting from the use of direct current; and, (3) measurement of resistivity at a time when the soil contained more or less moisture than normal. The first two of these possible errors would result in too high values for resistivity. To determine the extent of these errors, water was added to the air-dry samples of soil to bring them to the moisture equivalent, which is the amount of moisture retained by the soil when saturated soil is subjected for 1 hour to a centrifugal force of 1,000 times the force of gravity. This treatment reduces soils to their normal moisture content except in cases in which the water table is high. The resistivity of the moist sample then was measured by means of a thousand-cycle current. The correlation between the results of these measurements and the corresponding maximum pit depths is shown in Fig. 11. Perhaps the most surprising thing about this chart is that the maximum resistivity observed is much greater than that found for field resistivities. This tendency toward higher resistivities is confirmed by results of two independent sets of measurements of resistivities of the samples at saturation. These results do not differ greatly from the resistivities at moisture equivalent. A possible explanation for the high resistivities found in the laboratory is that the soil tested in the laboratory was less compact than the undisturbed soil in the field.

Comparisons of Figs. 8 and 11 indicate that the resistivities obtained in the field by means of the Shepard apparatus are as satisfactory as those obtainable in the laboratory so far as correlation with pit depths is concerned. No attempt was made to correlate the resistivity of saturated soil with pit depths.

**Soil acidity as a measure of corrosivity.**

Denison and Hobbs[11] have shown that there is a relation between the total acidity of acid soils and their corrosiveness, and Denison[12] has described a method for measuring soil acidity. Ewing[3] has developed a more rapid, although slightly less accurate, method.

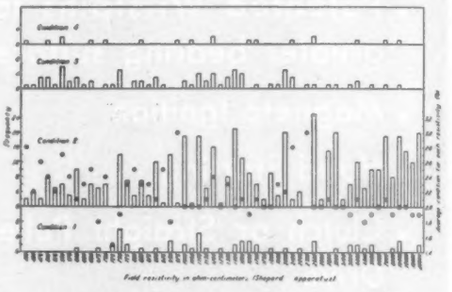

*Fig. 10—Relation between readings obtained with Shepard's resistivity meter and the condition of the joint of pipe nearest the point where the resistivity was measured (compare with Fig. 7)*

For the soils under discussion, as Fig. 12 shows, the correlation between acidity and corrosiveness is not good—partly because of insufficient data for the highly acid soils, and partly because of the number of soils containing little or no acid.

Hydrogen-ion values have been used also as indicators of soil corrosivity. The pH value of a soil solution indicates the hydrogen-ion concentration

**TABLE 6—COMPARISON OF METHODS OF TESTING SOILS ON BASIS OF CORRECT ARRANGEMENT OF SOILS IN THE RANK OR ORDER OF CORROSIVENESS**

| Soil series | Rank: By adjacent maximum pit | Rank: By average maximum pit | Shepard resistivity meter — Deviation: Rank | By adjacent maximum pit | By average maximum pit | Resistivity-at-moisture equivalent — Deviation: Rank | By adjacent maximum pit | By average maximum pit | Total acidity — Deviation: Rank | By adjacent maximum pit | By average maximum pit | Acidity times 1,000 / Resistivity — Deviation: Rank | By adjacent maximum pit | By average maximum pit | Modified Columbia rod test — Deviation: Rank | By adjacent maximum pit | By average maximum pit | Putnam test — Deviation: Rank | By adjacent maximum pit | By average maximum pit | Nipple-and-can test — Deviation: Rank | By adjacent maximum pit | By average maximum pit | Denison electrolytic cell — Deviation: Rank | By adjacent maximum pit | By average maximum pit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acadia | 11 | 9 | 9 | −2 | 0 | 5 | −6 | −4 | 10 | −1 | +1 | 11 | 0 | +2 | 10 | −1 | +1 | 8 | +3 | −1 | 10 | −1 | +1 | 9 | −2 | 0 |
| Brown | 8 | 7 | 11 | +3 | +4 | 11 | +3 | +4 | 4 | −4 | −3 | 5 | −5 | −2 | 9 | +1 | +2 | 11 | +3 | +4 | 9 | +1 | +2 | 6 | −2 | −1 |
| Caddo | 4 | 3 & 4 | 1 | −3 | −2 | 1 | −3 | −2 | 6 | −2 | +2 | 1 | −3 | −2 | 1 | −3 | −2 | 1 | −3 | −2 | 1 | −3 | −2 | 3 | −1 | 0 |
| Conglomerate | 9 | 11 | 7 | −1 | −4 | 8 | −1 | −3 | 1 & 2 | −7 | −9 | 3 | −7 | −8 | 3 | −7 | −8 | 7 | −2 | −1 | 11 | +2 | 0 | 11 | +2 | 0 |
| Crowley | 7 | 8 | 4 | −3 | −4 | 7 | −2 | −1 | 9 | +2 | +1 | 8 | +1 | 0 | 8 | +1 | 0 | 4 | −2 | −4 | 2 | −5 | −6 | 8 | +1 | 0 |
| Dark brown | 1 | 3 & 4 | 2 | −1 | −1 | 4 | +3 | 0 | 1 & 2 | 0 | −1 | 2 | +1 | −1 | 5 | +4 | +1 | 3 | +2 | 0 | 5 | +4 | +1 | 1 | 0 | −2 |
| Lake Charles | 10 | 10 | 8 | −2 | −2 | 9 | −1 | −1 | 8 | −2 | −2 | 12 | +2 | −1 | 11 | +1 | +1 | 10 | 0 | 0 | 7 | −3 | −3 | 10 | 0 | 0 |
| Leaf | 6 | 6 | 6 | 0 | 0 | 6 | 0 | 0 | 12 | +4 | +2 | 9 | +3 | +2 | 6 | 0 | 0 | 6 | 0 | 0 | 6 | 0 | 0 | 4 | −2 | −2 |
| Light gray | 12 | 12 | 12 | 0 | 0 | 12 | 0 | 0 | 3 | −9 | −7 | 10 | −2 | −1 | 12 | 0 | 0 | 12 | 0 | 0 | 12 | 0 | 0 | 12 | 0 | 0 |
| Myatt | 2 | 2 | 10 | +8 | +8 | 10 | +8 | +8 | 5 | +3 | +3 | 6 | +4 | +4 | 7 | +5 | +5 | 9 | +7 | +7 | 3 | +1 | +1 | 7 | +5 | +5 |
| Ochlockonee | 3 | 1 | 3 | 0 | +2 | 2 | −1 | +1 | 11 | +8 | +10 | 7 | +4 | +6 | 2 | −1 | +1 | 2 | −1 | +1 | 4 | +1 | +3 | 2 | −1 | +1 |
| Segno | 5 | 5 | 5 | 0 | 0 | 3 | −2 | −2 | 7 | +2 | +2 | 4 | −1 | −1 | 4 | −1 | −1 | 5 | 0 | 0 | 8 | +3 | +3 | 5 | 0 | 0 |
| Σ | .. | .. | .. | 24 | 27 | .. | 28 | 26 | .. | 44 | 47 | .. | 31 | 33 | .. | 24 | 22 | .. | 24 | 23 | .. | 24 | 22 | .. | 16 | 11 |
| Rank | .. | .. | .. | 2 | 6 | .. | 6 | 5 | .. | 8 | 8 | .. | 7 | 7 | .. | 2 | 2 | .. | 2 | 4 | .. | 2 | 2 | .. | 1 | 1 |

of the soil solution, but not the available acid in the soil. For this reason pH values are not satisfactory as indicators of corrosivity, and no correlation between pH values and pit depths was attempted.

**Acidity-resistivity test.**

For an old pipe-line system in northern Ohio Ewing[3] found that an equation involving both soil acidity and soil resistivity represented the cost of maintaining the pipe line better than equations involving either of these factors alone. The equation is:

$$C = \frac{k\ (\text{acidity}—5)}{\text{resistivity}}$$

*Where:* $C$ is the annual cost of maintaining a bare pipe line by repairing leaks and by reconditioning; $k$ is a constant depending on unit costs, the pipe-line diameter, and wall thickness. The acidity is expressed in milligram equivalents per 100 grams of soil, and the resistivity in ohm-centimeters at 60° F. (15.5° C.) for the saturated soil. The equation, obviously, is not applicable to soils which have an acidity less than 5 milligram equivalents; and, therefore, it is not applicable to the soils on this pipe line—many of which have acidities below this value. In Fig. 13 values for the expression $\frac{\text{1,000 times acidity}}{\text{resistivity}}$ have been plotted against the maximum adjacent pit depth. Those soils with acidities near zero, of which there are 46 samples, all are thrown in one group, and two-thirds of all the samples are thrown in the first three groups. It is impossible to subdivide these groups further because of the inaccuracy of the acidity measurement. In fact, it is doubtful whether there is a real difference in the acidity of these three groups. Hence to all intents and purposes, this method throws two-thirds of all the soil samples into one group, whereas with resistivity measurements alone these same soil samples are spread over a considerable range of value.

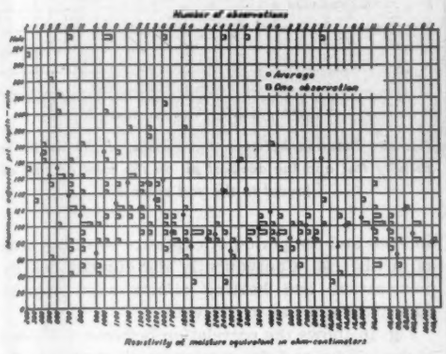


*Fig. 11—Relation between values of soil resistivity at moisture equivalent and the depth of the deepest pit on the joint of pipe adjacent to the soil sample (compare with Fig. 8)*

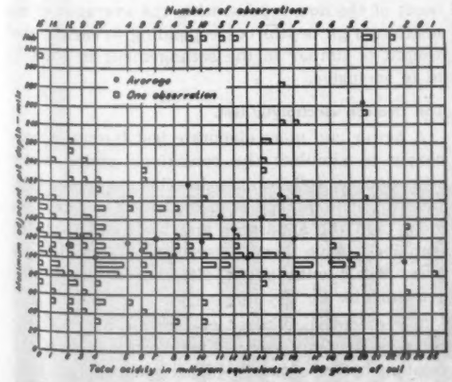


*Fig. 12—Relation between total acidity of soil samples and the depth of the deepest pit on the joint of pipe adjacent to the sample*

**The Columbia rod test.**

Legg[13] has developed an apparatus known as the Columbia rod for determining the corrosivity of soils. This apparatus avoids the use of an external battery and a voltage higher than would develop usually between two nearby points on the surface of a pipe. It consists of a tube, on the pointed lower end of which are two rings or a ring and a metal point—one of ferrous and the other of nonferrous metal, insulated from each other and from the rod. The rod is driven into the soil or thrust into a suitable hole, and the current which flows is measured by a milliammeter connected between the electrodes.

In the present study the Columbia rod was not used in the field. To get some idea of the results which might be expected from such apparatus, a bakelite frame was constructed which held a copper and an iron electrode 3 cm. apart. These electrodes were intended to serve the same purpose as the electrodes of the Columbia rod. The area of each electrode was 30 sq. cm., which was about half the area of the electrodes on one of the earlier forms of the Columbia rod. Soil at moisture equivalent was packed between the electrodes, a milliammeter was connected between them, and the average current over a period of 5 minutes was determined. This current was taken as a measure of the corrosivity of the soil. The correlation between this current and maximum pit depths is shown in Fig. 14. The pit depths appear to be roughly proportional to the currents. It would be difficult to determine whether these data do justice to the Columbia rod. In addition to the resist-


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ance of the soil, there are some polarization effects. This was shown by the use of a cell having different dimensions. The effects of polarization to some extent are a function of current density, which in the test cell under consideration is a function of the separation of the electrodes. As the relative effects of soil resistivity and polarization depend on the distance between the electrodes, a change in the dimensions of the test block might change the apparent precision of the test.

**The Putnam test.**

Putnam's[14, 23, 25] methods for determining soil corrosivity were among the first to give consideration to factors in corrosion other than resistivity. An attempt is made to take account of the potential of the soil with respect to the pipe and polarization as well as soil resistivity. The method in practice consists of observing the current which will flow across a 1-in. cube of soil subjected to a potential of 1.4 volts, although nothing in the theory of the test precludes the use of another volume of soil if the observed current is corrected for the difference in the resistance of the circuit. In the test as conducted at the bureau, soils at moisture equivalent were tested by means of the container used in the Columbia rod test, except that a steel plate was substituted for the copper electrode. To reduce the currents obtained to those obtainable with Putnam's apparatus, the currents shown in Fig. 15 should be divided by 3.9. There was slightly less polarization with the bureau's apparatus because of the slightly greater distance between the electrodes. Fig. 15 shows the correlation between the currents obtained with the modified Putnam apparatus and the maximum pit depths. This figure is similar to Fig. 14, but a close examination will show that the value of corrosiveness of the individual soil samples was not the same when obtained by the two methods.

**The nipple-and-can electrolytic test.**

The essential features of one of the most widely-used tests for soil corrosivity were described by Williams[17] in 1927. This test has been studied and modified by Corfield.[28] The test consists of determining the loss of weight of a 3-in. length of ¾-in. steel pipe caused by the passage of current at 6 volts. The pipe is surrounded by saturated soil contained in a can about 3 in. in diameter. Lack of soil makes it impossible to use an anode as long as Corfield's, but the diameters of the rod

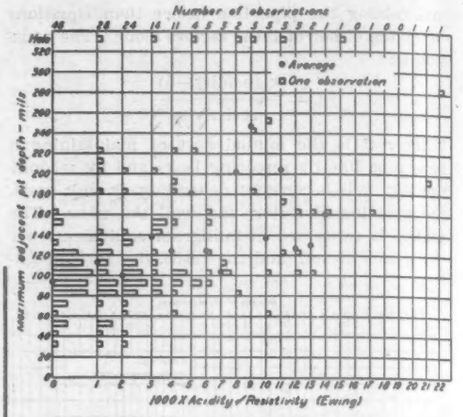


*Fig. 13—Relation between the results of the acidity-resistivity test and the deepest pit on the joint of pipe adjacent to the soil sample*

and can and the period of exposure were the same as in his test. Consequently the current density, polarization, and heating effects were approximately the same as in his tests.

Fig. 16 shows the correlation between the losses of the anodes and the maximum pit depths in the lengths of pipe adjacent to the soil samples. The losses of weight should be multiplied by four to

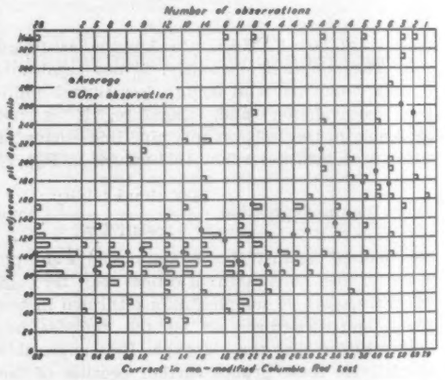
Number of observations
Average
One observation
Maximum adjacent pit depth - mils
Current in ma - modified Columbia Rod Test

*Fig. 14—Relation between current in the modified Columbia rod test and maximum pit depths*

make them comparable with those which would be obtained with a full-length anode. The arrangement of the dots representing the averages of the maximum pit depths corresponding to each loss of weight is similar to the arrangement in Figs. 13 to 16, inclusive.

**The Denison electrolytic test.**

A newer and more elaborate test intended more nearly to simulate the conditions under which corrosion in soils occurs has been proposed by Denison. The method is in the process of development, and the apparatus and the methods to be employed have been described in several papers,[4, 22, 26, 21] with slight differences due to improvements.

The essential features of the test are that the corrosivity of soil samples is determined from the relation between current density and potential in a cell in which the anode is a steel disc and the cathode a steel screen. The soil is especially pre-

*(Continued on Page 159)*


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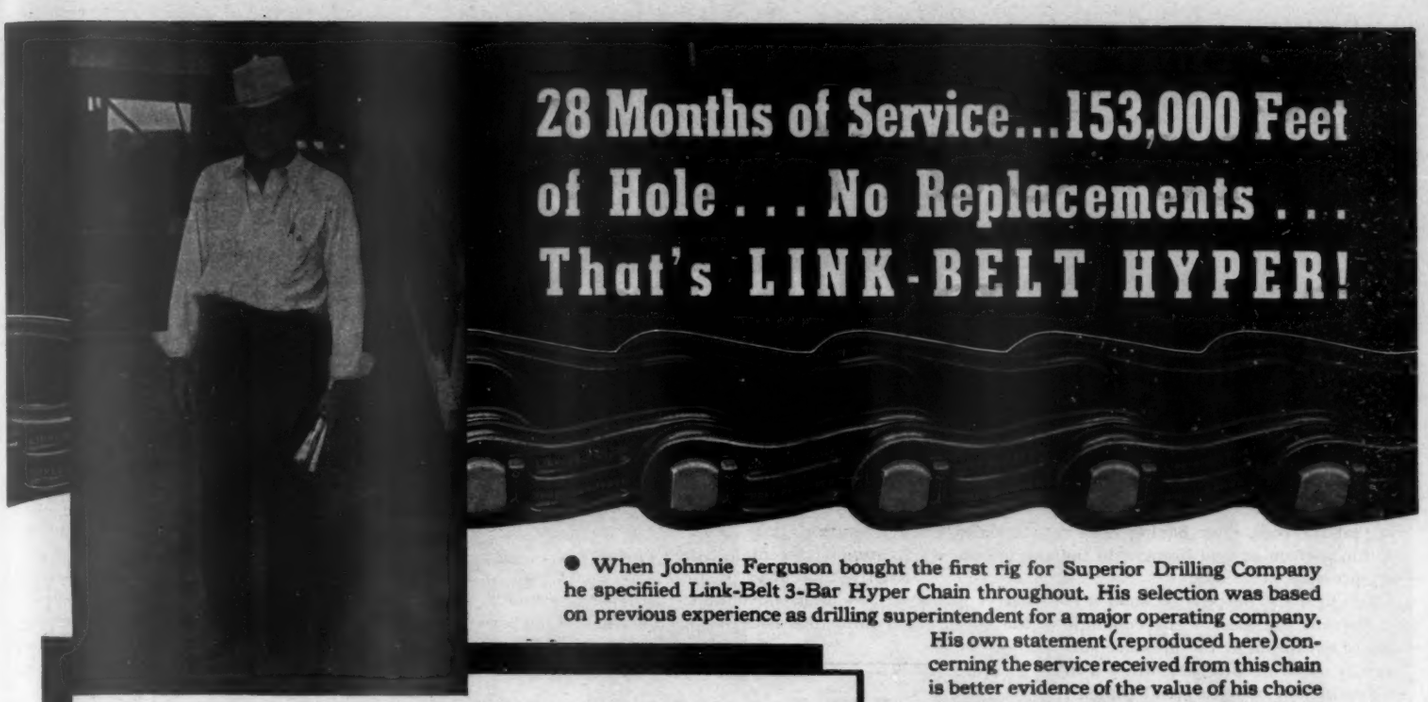

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# LINK-BELT CHAINS

## THE CHOICE OF EXPERIENCED DRILLERS

# The Carter Pressure Core Barrel

By BEN W. SEWELL
The Carter Oil Co., Tulsa, Okla.

A PRESSURE core barrel is a coring device which differs from conventional core barrels in that the core, after having been cut, is sealed within a chamber and brought to the surface under pressure.

The primary purpose of such a core barrel is to prevent the loss of the contents of the core due to expansion as the pressure surrounding the core is reduced, thus permitting a more accurate determination of its original content.

### Core-Barrel Applications

A discussion of the entire field of pressure-core applications is beyond the scope of this paper; the more general uses include the following:

1. A more certain determination of reservoir content than is furnished by the conventional nonpressure-type core barrel.
2. Location of gas caps and determination of content.
3. Studies of oil, gas, and water gradients through a producing zone.
4. Studies in well spacing.
5. Studies of oil remaining in place in depleted fields by drilling and coring intermediate wells.
6. Studies of various methods and rates of production by working on cores while cores are under pressure.
7. Studies of contamination of cores.

Briefly, the Carter pressure core barrel may be described as a conventional core barrel containing a third tube between the inner and outer barrels. This third tube is provided with valves at both ends, and an arrangement for lifting the inner barrel containing the core up into it—after which the valves are closed. All of these operations occur at the bottom of the hole. Figs. 1 and 2 illustrate the principles of operation.

**A.P.I. — Presented before annual meeting, Chicago, Ill., November 17, 1939**

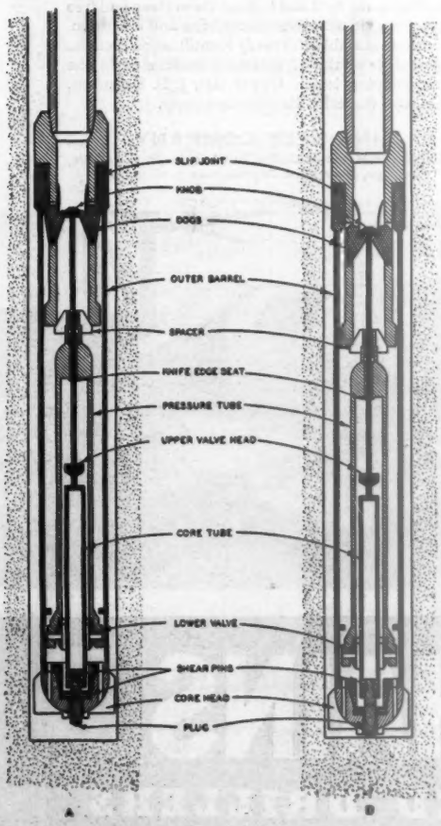


*Fig. 1—Diagrams illustrating the operation of the Carter pressure core barrel*

Fig. 1-*A* shows the core barrel as it goes down the bore hole. At the lower end of the assembly, located in the central passage through the core head and extending up into the end of the core tube, is a plug which serves a double purpose. This plug is attached by one set of shear pins to the outer assembly, and by another set of shear pins to the core tube. By this means the core tube is held in a fixed position relative to the outer assembly as the core barrel is lowered into the hole. The plug also, as in a conventional core barrel, prevents cavings from entering the core tube. Attached to the upper end of the core tube and extending upward is a rod which has on its uppermost end a knob or boss. This knob, when in the position shown in Fig. 1-*A*, holds the two adjacent dogs in such a position that their outer shoulders abut a similar shoulder in the outer shell—thus serving to lock the outer shell in the position shown relative to the drill stem. Notice that the drill stem is not attached rigidly to the outer shell of the core barrel, but has interposed a slip joint which permits relative vertical motion between the two when the locking dogs are disengaged.

Between the core tube and the outer shell is placed a pressure tube. This tube has at its lower end a ball plug valve of a special design. At its upper end is provided a head containing a knife-edge seat encircling the rod which extends up from the core tube. A detailed explanation of these valves will be made later.

### Core Barrel at Bottom

Fig. 1-*B* shows the core barrel when it reaches bottom. The lower set of rivets is sheared as the plug comes in contact with the bottom of the bore hole. This causes the core tube, upper rod, and knob to stop momentarily while the remainder of the core barrel continues downward—resulting in sufficient motion to force the dogs down below the knob and allow them to snap inward and latch under the lower edge of the knob, as shown in Fig. 1-*B*. Provision is made to limit the vertical motion of the core-tube assembly so that, after the releasing operation is complete, the upper set of rivets shear and permit the core to enter the core tube—pushing the plug ahead. After this releasing operation has taken place, the core barrel must not be lifted off bottom until sufficient core has been cut.

### Core Cut and Drill Pipe Lifted

Fig. 2-*A* shows the core having been cut, and the drill pipe lifted a short distance. The outer shell remains on bottom, and the two dogs are latched under the knob and have lifted the core tube with the core up into the pressure tube. Near the lower end of the rod attached to the core tube is a valve head provided with a soft gasket on its upper surface. It can be seen in Fig. 2-*A* that this valve head has come in contact with the knife-edge seat provided in the pressure-tube

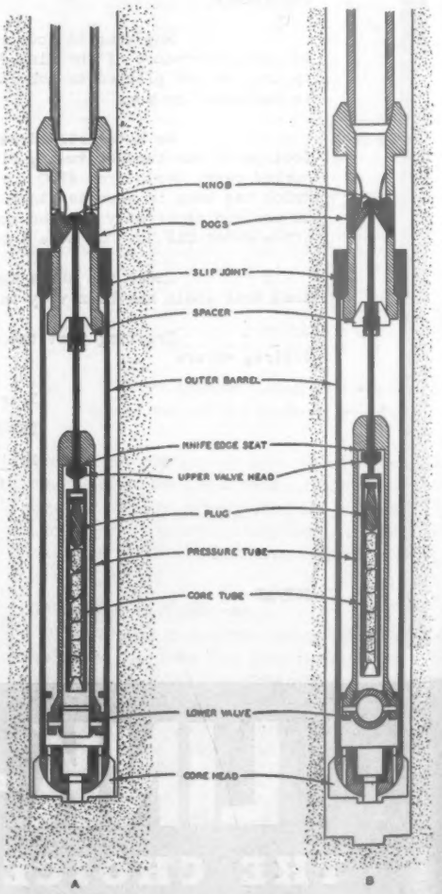


*Fig. 2—Diagrams illustrating the operation of the Carter pressure core barrel*

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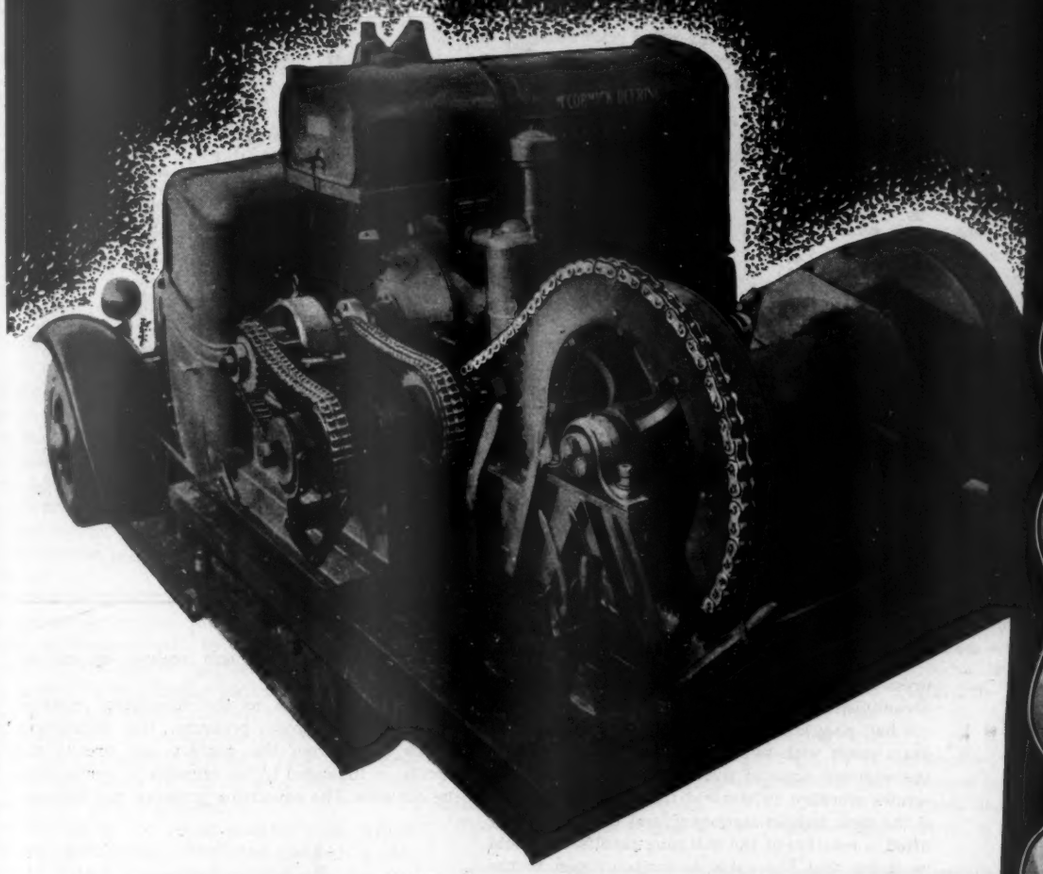

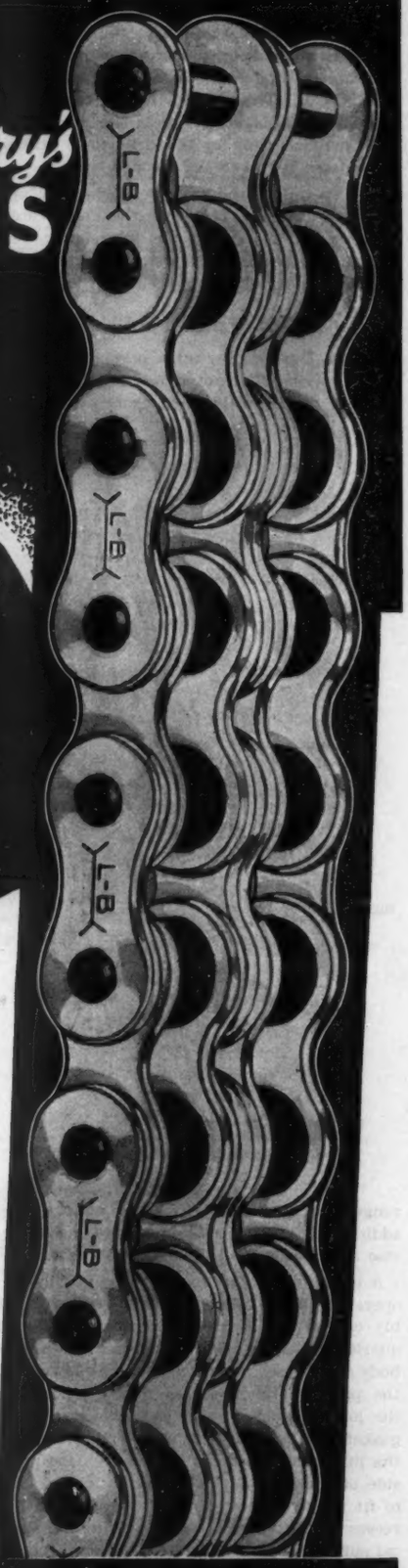


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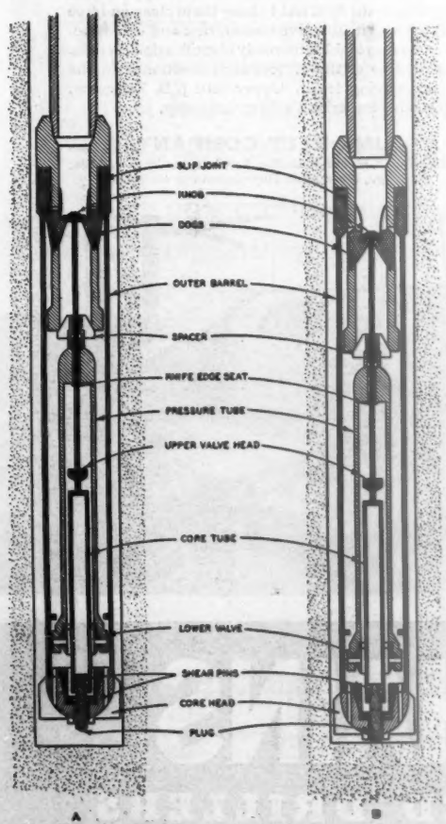


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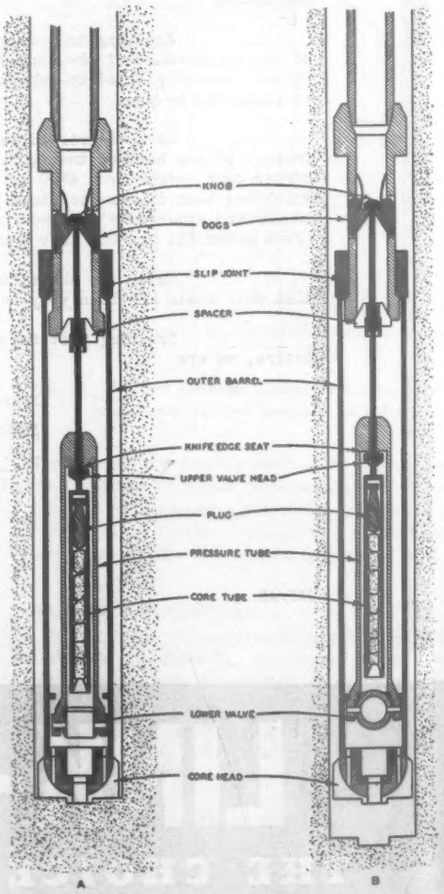


*Fig. 2—Diagrams illustrating the operation of the Carter pressure core barrel*

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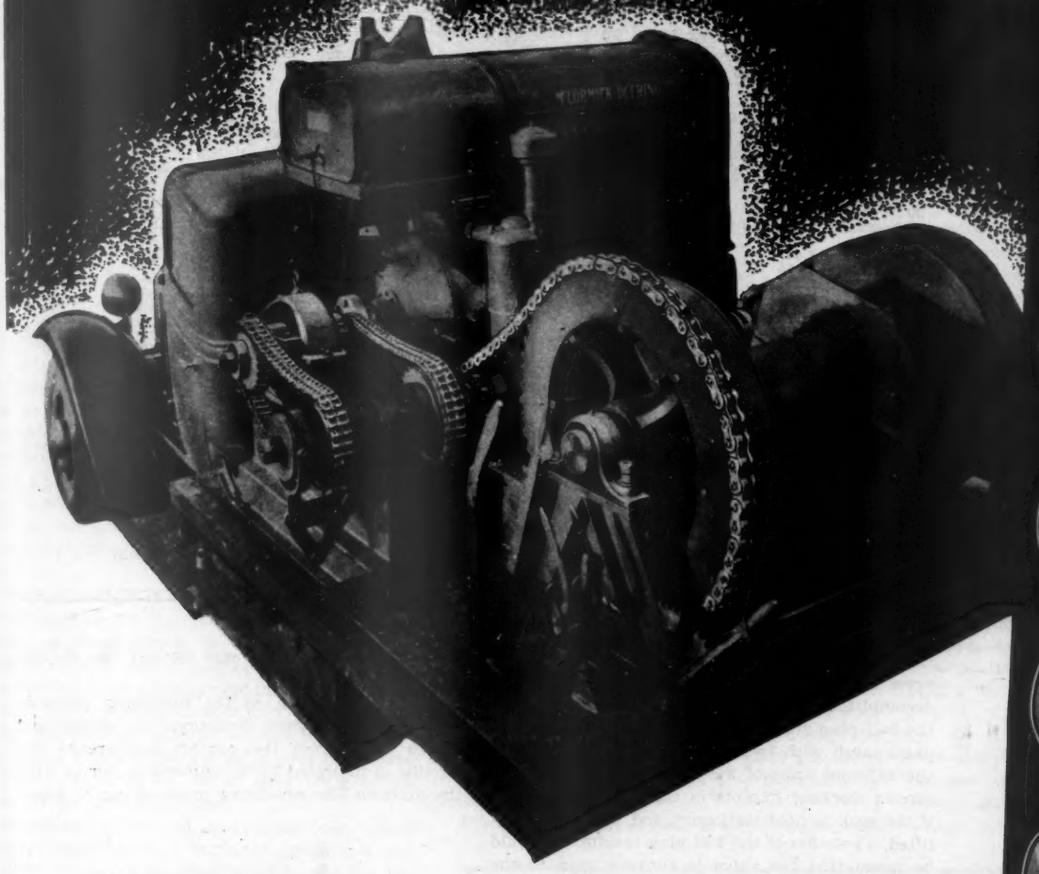

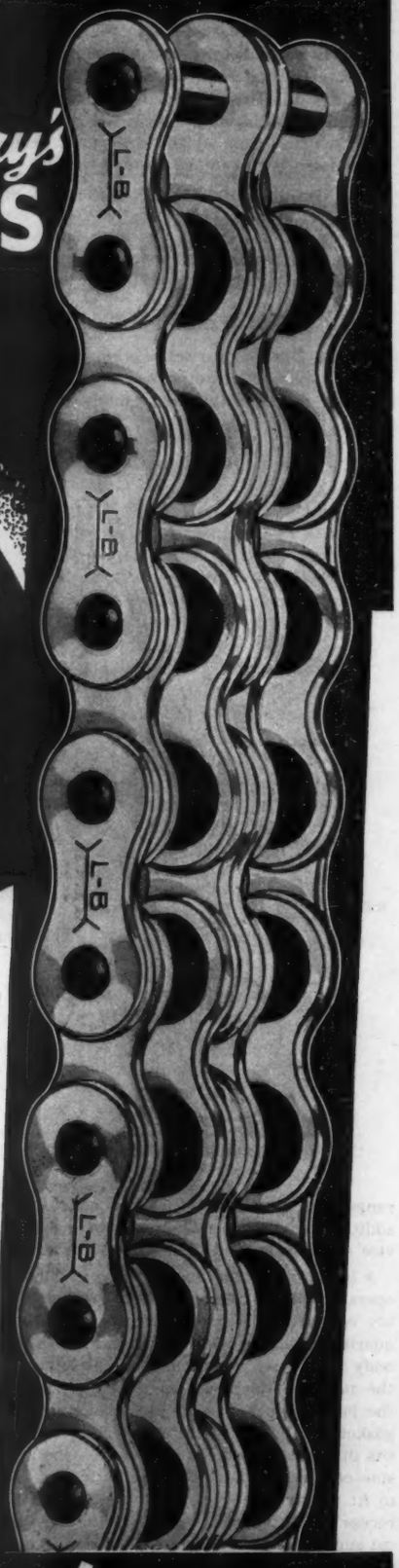


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head. This action seals the upper end of the pressure tube. Further lifting of the drill stem will cause the pressure-tube assembly to be lifted a sufficient distance relative to the outer shell to cause a rack-and-pinion arrangement on the lower valve to rotate and close this valve, as shown in Fig. 2-*B*. This operation has completed the process of sealing the core in the pressure tube, and further lifting of the drill stem brings the entire core barrel to the surface.

The operations required to lift the core up into the pressure tube and close the valves are progressive actions caused by the relative vertical motion between the drill stem and the outer shell of the core barrel, and are entirely automatic.

### Sectional Design Details

In Fig. 7 are shown full sectional details of the actual core-barrel design. A careful examination of these details will reveal exactly the same arrangement illustrated by Figs. 1 and 2, with the addition of various refinements to make the device structurally and dimensionally practical.

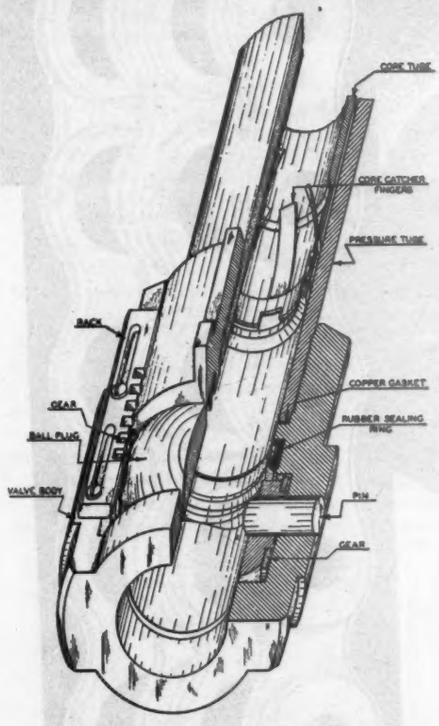


*Fig. 3—Detail of lower valve assembly*

A better understanding of the construction and operation of the all-important lower valve assembly can be had by reference to the perspective quarter-section drawing shown in Fig. 3. The valve body can be seen screwed onto the lower end of the pressure tube with a copper gasket sealing the joint against pressure. Just below the copper gasket can be seen a rubber sealing ring which fits in a recess in the valve body on the pressure side of the ball plug. This sealing ring is shaped to fit snugly in the configuration formed by the recess in the valve body and against the spherical surface of the ball plug. The lower lip of the rubber sealing ring presses firmly against the ball when no pressure differential exists, and forms a positive self-sealing closure when a pressure differential develops. The valve is shown with the ball plug in the open position. A large portion of the ball which normally would come in contact with the rubber ring when the valve is open has been cut away. This was done to prevent the rubber sealing ring from sticking or vulcanizing to the ball when the valve is left standing in the open position for a long period of time.

**TABLE I—LOG OF PRESSURE CORE-BARREL RUNS TO DATE**

| Test No. | Depth (ft.) | Average table speed (r.p.m.) | Average weight on bit (1,000 lb.) | Mud pressure (lb. per sq. in.) | Rate of mud flow (g.p.m.) | Core cut (in.) | Core recovered (in.) | Static bottom-hole mud pressure (lb. per sq. in.) | Pressure in core barrel (lb. per sq. in.) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,533 | 50 | 3 | 200 | ... | 66 | 36 | .... | 90 |
| 2 | 1,491 | 55 | 4 | 200 | ... | 60 | 12 | .... | 0 |
| 3 | 1,470 | 40 | 5 | 200 | ... | 36 | 36 | .... | 530 |
| 4 | 1,551 | 40 | 5 | 250 | ... | 60 | 48 | .... | 0 |
| 5 | 1,492 | 40 | 5 | 200 | ... | 60 | 57 | .... | 0 |
| 6 | 1,559 | 40 | 5 | 200 | ... | 60 | 48 | .... | 620 |
| 7 | 1,500 | 45 | 5 | 200 | ... | 72 | 33 | 818 | 500 |
| 8 | 1,591 | 50 | 8 | 250 | ... | 10 | 0 | .... | 590 |
| 9 | 1,558 | 45 | 5 | 200 | ... | 72 | 60 | .... | 0 |
| 10 | 1,565 | 60 | 8 | 200 | ... | 72 | 0 | .... | 0 |
| 11 | 1,516 | 55 | 6 | 200 | ... | 72 | 60 | .... | 420 |
| 12 | 1,542 | 50 | 8 | 200 | ... | 0 | 0 | .... | 460 |
| 13 | 1,434 | 50 | 7 | 250 | ... | 72 | 72 | .... | 0 |
| 14 | 1,440 | 60 | 7 | 300 | ... | 60 | 18 | .... | 0 |
| 15 | 1,540 | 55 | 7 | 200 | ... | 44 | 40 | 850 | 610 |
| 16 | 1,510 | 45 | 6 | 200 | ... | 72 | 62 | 830 | 520 |
| 17 | 1,516 | 50 | 7 | 200 | ... | 72 | 18 | 835 | (*) |
| 18 | 1,505 | 55 | 6 | 200 | ... | 72 | 60 | 845 | 690 |
| 19 | 1,511 | 50 | 6 | 200 | ... | 72 | 54 | 830 | 600 |
| 20 | 1,567 | 55 | 6 | 250 | ... | 72 | 69 | 880 | 0 |
| 21 | 1,573 | 60 | 7 | 200 | ... | 50 | 37 | 880 | 410 |
| 22 | 1,483 | 60 | 7 | 175 | ... | 32 | 20 | 850 | 450 |
| 23 | 1,495 | 60 | 4 | 175 | ... | 72 | 68 | 865 | 0 |
| 24 | 1,376 | 60 | 5 | 150 | ... | 72 | 24 | 760 | 750 |
| 25 | 1,382 | 50 | 5 | 150 | ... | 72 | 4 | 760 | 710 |
| 26 | 5,253 | 45 | 7 | 300 | 194 | 72 | 40 | 2,810 | 100 |
| 27 | 5,279 | 45 | 8 | 300 | 160 | 8 | 0 | 2,880 | 925 |
| 28 | 5,280 | 30 | 10 | 300 | 172 | 6 | 0 | 2,960 | 1,400 |
| 29 | 5,280.5 | 45 | 9 | 300 | 217 | 48 | 21 | 2,860 | 600 |
| 30 | 5,319 | 50 | 9 | 300 | 206 | 27 | 24 | 2,870 | 1,600 |
| 31 | 1,441 | 55 | 5 | 150 | 270 | 78 | 32 | 800 | 590 |
| 32 | 1,447 | 55 | 5 | 150 | 282 | 72 | 35 | 805 | 665 |
| 33 | 1,455 | 45 | 5 | 140 | 259 | 72 | 17 | 795 | 545 |
| 34 | 1,564 | 50 | 5 | 140 | 259 | 78 | 22 | 855 | 700 |
| 35 | 1,521 | 50 | 5 | 140 | 247 | 77 | 20 | 890 | 710 |
| 36 | 1,446 | 45 | 5 | 140 | 259 | 78 | 74 | 805 | 740 |
| 37 | 1,446 | 45 | 6 | 140 | 247 | 78 | 2 | 790 | 610 |
| 38 | 1,407 | 60 | 6 | 130 | 212 | 24 | 12 | 775 | 0 |
| 39 | 1,434 | 45 | 4 | 130 | 224 | 78 | 78 | 785 | 640 |
| 40 | 1,519 | 55 | 6 | 150 | 247 | 78 | 64 | 875 | 710 |
| 41 | 1,523 | 60 | 6 | 110 | 200 | 42 | 28 | 860 | 670 |
| 42 | 1,510 | 60 | 8 | 150 | 212 | 78 | 56 | 850 | 600 |
| 43 | 1,516 | 65 | 8 | 170 | 200 | 78 | 74 | 890 | 550 |
| 44 | 1,414 | 50 | 7 | 170 | 236 | 78 | 48 | 785 | 0 |
| 45 | 1,565 | 55 | 8 | 170 | 212 | 78 | 37 | 925 | 700 |
| 46 | 1,475 | 45 | 7 | 130 | 212 | 78 | 2 | 850 | 640 |
| †47 | 1,535 | .. | .. | ... | | 0 | 0 | 870 | 440 |
| 48 | 1,538 | 50 | 7 | 130 | 224 | 78 | 38 | 880 | 695 |
| 49 | 1,565 | 45 | 8 | 140 | 212 | 78 | 48 | 900 | 610 |
| 50 | 1,568.5 | 50 | 9 | 110 | 212 | 78 | 59 | 850 | 630 |

*High, but undetermined.
†This test was made to get a sample of drilling mud under pressure to determine its gas content.

The ball plug is pivoted on two pins which press into the valve body. Rotation of the ball is accomplished by means of two gears attached to the ball plug and concentric with the pins. These gears mesh with two racks held in place against the adjacent arms of the valve body by shoulder screws working in slots in the racks. Therefore, if the rack is held stationary and the valve body lifted, a rotation of the ball plug results. It should be noted that the valve is entirely open to the flushing action of the mud stream which flows by it during the entire coring process.

The core tube, with the core-catcher arrangement in its lower end, is shown in Fig. 3, drawn up above the lower valve. During coring it is thrust through the opening in the valve to receive the core, and then is lifted to permit closing the valve.

### Needle Valve in Head

There are several details included in the pressure-tube head which have not been described. In order to provide a means of bleeding off the contents of the pressure tube, a needle valve was built into the head. An opening is provided in the side by means of which the pressure chamber may be connected to any equipment desired.

In addition, an arrangement is provided in the head which permits accurate determination of pressure within the pressure tube. A diagrammatic sketch of this scheme is shown in Fig. 4. It consists of a metallic diaphragm with the pressure to be measured on one side and provision for building up an equalizing pressure on the opposite side. In the center of the diaphragm, on the equalizing pressure side, is an electrical contact which makes or breaks the circuit—depending upon the position of the diaphragm. When no equalizing pressure is applied, the electrical circuit is closed by the pressure to be measured—which forces the diaphragm against the stationary contact.

As soon, however, as the equalizing pressure equals the unknown pressure, the diaphragm moves away from the contact and breaks the circuit, as indicated by an ohmeter in series with the contacts. The equalizing pressure can be meas-

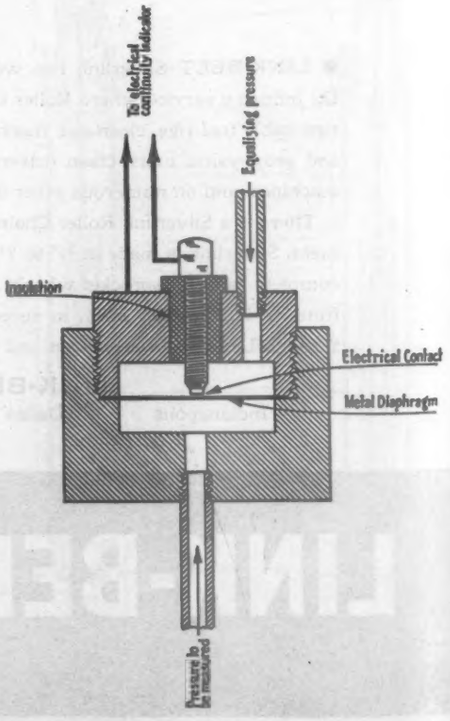


*Fig. 4—Diagram of pressure-measuring arrangement*

ured by a deadweight test indicator or by any standard type of pressure gage.

The diaphragm and contact is built into the presure-tube head, and all other equipment is attached after the core barrel has been brought to the surface.

The core catcher made into the lower end of the core tube merely consists of spring fingers which slip into place in slots provided in the core tube and hold there by their own spring tension. They can be knocked out easily and replaced.

At the upper end of the core tube is a ball check valve similar in purpose and arrangement to valves used on conventional core barrels.

Just above this valve, a ball-thrust bearing per-

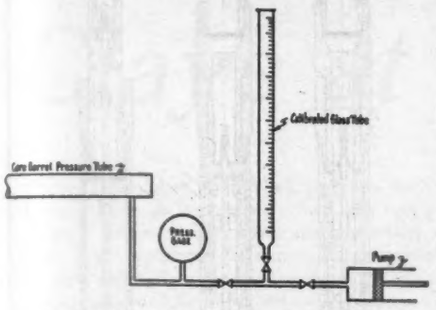


*Fig. 5—Diagram of laboratory test setup*

mits the core tube to float or remain stationary while the drill stem rotates.

On the lower end of the rod which extends upward from the core tube, and just above the ball-thrust bearing, can be seen the arrangement of the valve head and its removable soft seat. This soft seat is made in the form of a washer, and is held in place by the rod screwing into the valve head.

This rod actually is made in two parts to facilitate assembly. At the junction is an enlarged portion or boss—which, in conjunction with a shoulder in the spacer just above the pressure-tube head—acts as a limiter for the vertical movement of the core-tube assembly. This movement is just sufficient to release the locking dogs.

A helical compression spring is provided above the releasing knob so as to hold both valves closed under spring tension.

In addition to the set of locking dogs which hold the assembly in a retracted position, a second pair of dogs is provided to latch over the top shoulder of the outer shell assembly (see Fig. 7) when the slip joint has reached its limits of extension. Thus, once the barrel has locked itself in an extended position, weight can be applied without reversing the procedure.

It should be pointed out that the inner assembly—consisting of core tube, pressure tube, and its associated valves—slips into place within the outer shell, being held there by a cap on the lower end of the outer assembly. The inner assembly—containing a core under pressure—then either can be worked on in the field or be shipped to a laboratory for analysis. As many spare inner assemblies as are required may be made available; however, it is possible to remove the core from one assembly in the field and have it ready to go back into the well in a reasonably short time if necessary. In practice we have found it more convenient to have two inner assemblies, even when the core is removed on location.

### Pressure Core-Barrel Tests

A complete record of all tests which have been made to date with this pressure core barrel is given in Table 1.

In regard to the data in Table 1, it should be pointed out that the descriptions and details given in this paper represent the latest design, of which many features were developed in the course of the tests. The improvements made on the original design, plus greater operating experience, resulted in the marked betterment of the percentage of successful runs as the test progressed.

It is felt that, with further experience, the recovery of pressure cores should become almost a certainty, while the percentage of core recovery should correspond to the recovery by a conventional barrel cutting a core of a similar size. The pressure core barrel, as designed and in operation now, will hold a 1 11/16-in. by 6-ft. 6-in. core with a minimum outside core-head diameter of 6¼ in. The core diameter probably can be increased some without increasing the outside diameter of the barrel, and the length can be made anything within reasonable limits.

From an examination of the pressures recorded by the pressure core barrel on many of the tests to date, it is apparent that they are lower than one would expect after the static bottom-hole mud pressure has been computed.

Considerable thought was given this problem, and it was concluded that the pressure loss was due to at least one—and possibly all—of the following factors:

1. Elastic deformation of the pressure barrel and its valves.
2. Thermal effects.
3. Leakage.

In order to determine the possible magnitude of these factors, a series of tests and computations was made.

On the majority of tests made to date with the core barrel in the field, the pressure has been very sensitive to small changes in volume, and has had all the characteristics of liquid pressure. This, of course, would be true if no free gas were present in the core barrel at the pressure and temperature existing.

In order to determine the pressure-volume relationship for the pressure tube when completely filled with water, the test setup illustrated in Fig. 5 was made. A pressure of 3,000 lb. per sq. in. was built up in the pressure tube, and reduced in steps of 250 lb., with a measurement of the volume of water expelled at each step being recorded. It was found that the relationship was practically linear, and averaged 0.089 cu. in. of water per 100 lb. pressure—a total of 2.441 cu. in. of water representing a pressure drop from 3,000 lb. to 250 lb.

The total internal volume of the pressure tube was found to be 255 cu. in. at 0 lb. per sq. in. pressure.

Further tests were conducted, in which a steel bar having approximately the same volume as a full core was placed in the core barrel, and the remaining space filled with water. The same procedure was followed as on the previous tests, and it was found that a change in volume of 0.051 cu.

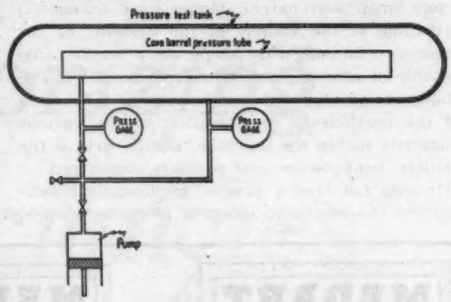


*Fig. 6—Diagram of laboratory test setup*

in. caused a change of 100 lb. pressure—a total of 1.135 cu. in. dropping the pressure from 3,000 lb. per sq. in to 250 lb. per sq. in.

Another series of tests was designed to simulate the conditions in a well with the pressure inside and outside the pressure tube equalized, followed by gradual reduction of the external pressure—with the effect on the internal pressure being noted.

In order to make this series of tests, the arrangement shown in Fig. 6 was used.

The results of these tests indicated that a change of 100 lb. external pressure caused a 16-lb. internal-pressure change. This condition seemed to be linear up to the maximum pressure used, which was 3,000 lb. per sq. in. differential.

Placing the same steel bar used in previous tests within the pressure tube and filling the remaining space with water, an external-pressure drop of 100 lb. caused an internal-pressure drop of 27.2 lb.

### Temperature and Pressure

In studying the possible effects of temperature changes on the pressure within the pressure tube, it was decided that the following changes occur which, in turn, affect the pressure:


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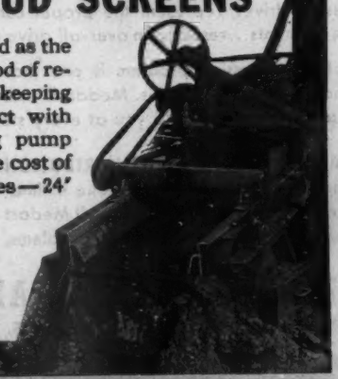

LINK-BELT Vibrating SCREEN

1. The internal volume of the pressure chamber changes with temperature.

2. The volume of the contents of the pressure chamber changes with temperature.

The change in the internal volume of the pressure chamber is dependent upon the coefficients of expansion of the materials of which it is made, as well as the size and shape of its components. The net effect of this change appears to be relatively small over narrow temperature changes.

Change in the volume of the contents of the pressure chamber with temperature seems to be capable of affecting the pressure materially. The change in volume with temperature is a function of the coefficients of expansion of the various materials within the pressure tube as well as the volume, temperature, and pressure considered.

It was felt that a precise mathematical solution for the combined effect of all factors would be impractical. However, in order to get a picture of the possible magnitude of the effects, a specific set of conditions and assumptions was made as follows:

1. That the change in internal volume of the pressure chamber with temperature is negligible.

2. That the pressure chamber is filled with 4.200 g. of water at 40° C.

3. Temperature change from 40° to 39° C.

4. That 1.457 ml. change in volume equals 100-lb.-pressure change (from previous tests).

Under this set of conditions, a volume change of 1.61 ml. results, which corresponds to a pressure change of 110.5 lb.

Although these tests and computations supply little in the way of practical field data, they do tend to substantiate the conclusion that the valves provided in the core barrel effectively are sealing the core in the pressure tube, with little if any loss of its contents as it is brought to the surface.

It is apparent, also, that the pressure core barrel does not necessarily indicate directly the static bottom-hole mud pressure. The pressure recorded is affected by a multiplicity of conditions, which are difficult to evaluate in practice.

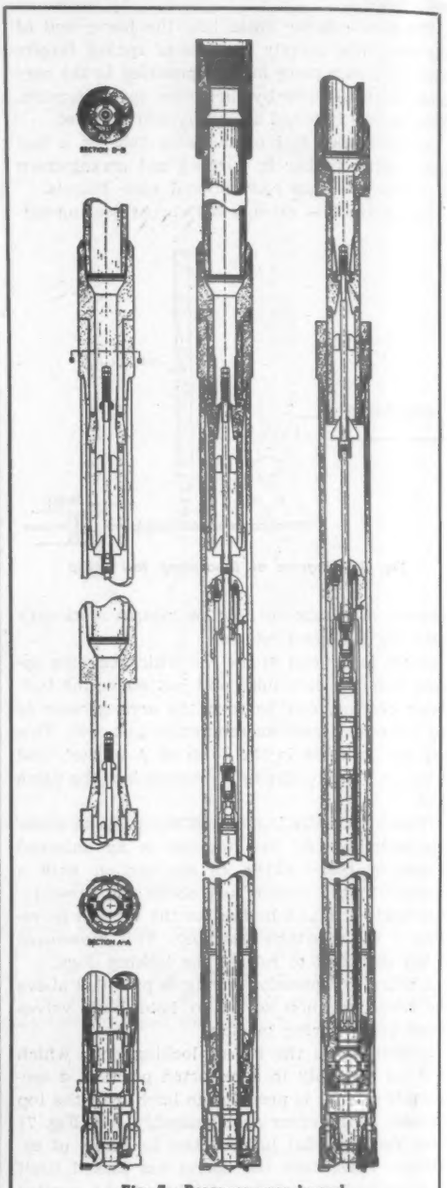

*Fig. 7—Pressure core barrel*

Numerous practical applications and advantages of a pressure core barrel have been suggested. Unfortunately, inasmuch as only one phase of such a problem can be attacked at once, so far very little actual work has been done other than to develop the tool that has just been described. The technique of coring and core analysis takes on a much broader aspect with pressure cores available, and many problems are yet to be solved or evaluated. Of these problems—perhaps for the time being anyway—contamination of cores from drilling mud is the most formidable. Just how serious it is, and what to do about it, are questions which are being investigated at this time. It has been noted, however, on numerous cores taken in the Louden pool in Illinois that, when the bleed-off needle valve is opened, a good core gives off considerable gas; and when the core is removed, there frequently is a noticeable evidence of oil that has bled off the core. This was the case even when the cores were cut with no particular precautions in treating the mud.


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# *Thermofor Kiln and Clay-Regeneration Processes for*

# *Maintaining Decolorizing Clays at High Efficiencies*

**By T. P. SIMPSON and J. W. PAYNE**
Socony-Vacuum Oil Co., Inc., Paulsboro, N. J.

IN the refining of mineral-oil products such as waxes, turbine and transformer oils, and particularly lubricants for internal-combustion engines and machinery, treatment by percolation through adsorptive substances such as clays is usually one of the most important operations. The purpose of this operation is to improve the color, color stability, odor, carbon residue, resistance to oxidation breakdown, and the demulsibility and, in the case of solvent-refined oils, to remove the last traces of solvent. Normally this operation is the final one conducted in finishing oils for markets.

Although many types of percolation adsorbents, such as bone char, silica gel, bauxite, and activated carbon, have been and still are employed extensively by the petroleum industry, the most common material in use today is fuller's earth. Fuller's earth is used so broadly throughout the petroleum industry today that the terms "fuller's earth" and "percolation clay" virtually are synonymous. Fuller's earth employed for this purpose is naturally active, has considerable compressive strength and hardness and, after tempering, is not disintegrated by water. It is most commonly applied in 30 to 60-mesh form; but 15-30, 20-90, 60-90, and other similar grades have found considerable use.

The yield of oil from a percolation filter depends to a large extent on the clay efficiency, the type of oil filtered, and the quality of product than five times in conventional burning equipment normally being only about half or less than half of those from fresh clays.

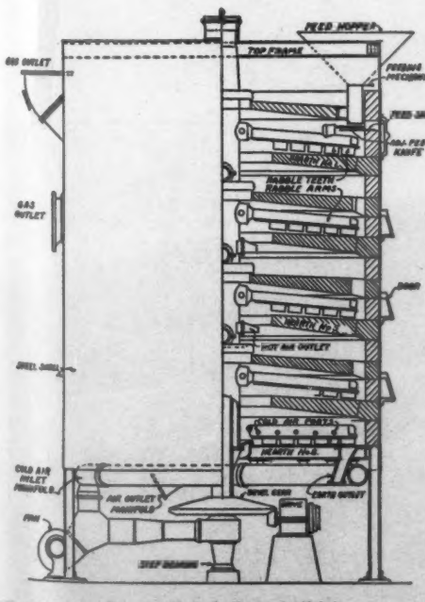


*Fig. 1—Nichols-Herreshoff kiln*

***A.P.I.*** **— Presented before annual meeting, Chicago, Ill., November 17, 1939**

desired. In regular refinery practice the yields of finished oils from percolation cover a range of 5 bbl. to 150 bbl. per ton of clay—the yields from used clays which have been regenerated more

In the operation of a percolation filter when the oil produced is no longer of quality satisfactory for incorporation into the finished product, the filter is taken off stream. Preparations then are made for washing the spent percolator to remove the suspended oil, and to condition the spent clay so that it may be regenerated. The usual procedure for washing consists of leaching the clay with naphtha, and subsequently steaming to remove the residual naphtha and oil. These operations are carried out while the clay remains in the filter; and when they have been completed, the clay is ready for the final regeneration step required to remove the adsorbed tarry matter. The latter operation can be carried out in two radically different ways: by burning and roasting, or by extraction with solvents. Burning is the older method, and is used exclusively throughout the petroleum industry on the commercial scale—and it is with burning type of regeneration that this paper deals.

The equipment most commonly used for clay burning was adapted largely from ore-roasting machinery. An installation usually consists of either a rotary kiln, or a Wedge or Nichols-Herreshoff burner—the latter representing the multiple-hearth type, or a combination of several of these. An illustration of a Nichols-Herreshoff multiple-hearth furnace is shown in Fig. 1. Conventional Wedge burners have a nominal capacity of about 120 tons per operating day, and Nichols-Herreshoff units normally run about 50 tons per day. A typical Wedge burner having a capacity of 5 tons per hour weighs about a million pounds, is about 25 ft. in diameter by 25 ft. in height, and has a burning-hearth area of about 1,600 sq. ft. Typical present-day lubricating-oil refineries have a capacity of clay-burning equipment of from 40 to 300 tons per day, consisting of one or more of these types of burners.

Although rotary kilns have been used by many refiners, practically all installations since 1930 have been of the multiple-hearth type, and in many instances rotary units have been abandoned in favor of the latter.

In multiple-hearth burners the material to be burned passes down through successive hearths against a countercurrent stream of air. The apparatus has very little provision for heat removal or temperature control other than that manually obtained by the spraying of water or steam on the apparently overheated hearths. A reactivation of this type necessitates the addition of supplementary heat, which is supplied by flames over the hearths or in Dutch ovens. By such procedure the burning of the carbonaceous matter results in detrimental overheating of the clay. The life of the clay is shortened by incineration

*(Continued on Page 150)*

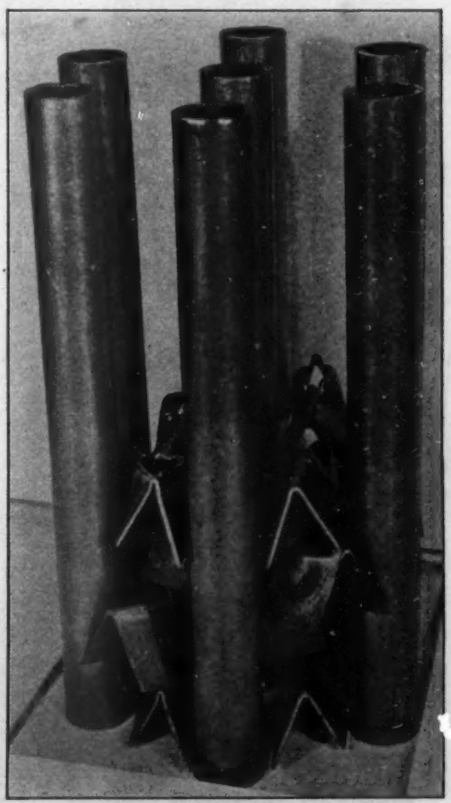

*Fig. 2—Tube and angle arrangement in typical Thermofor kiln*

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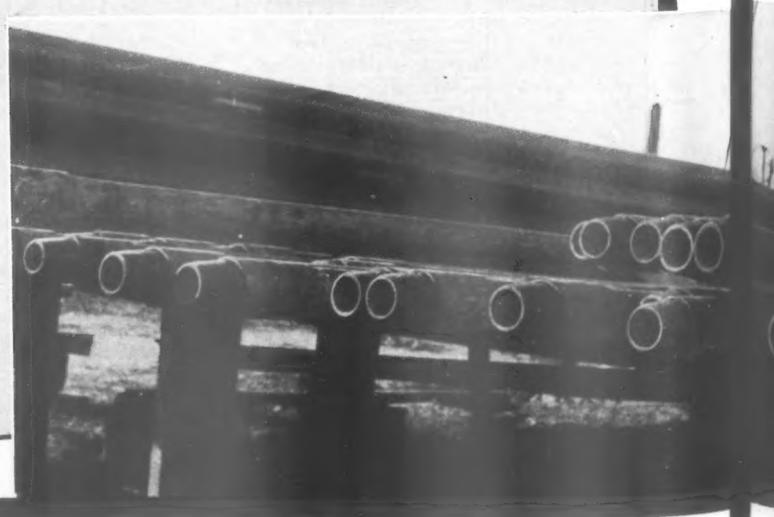

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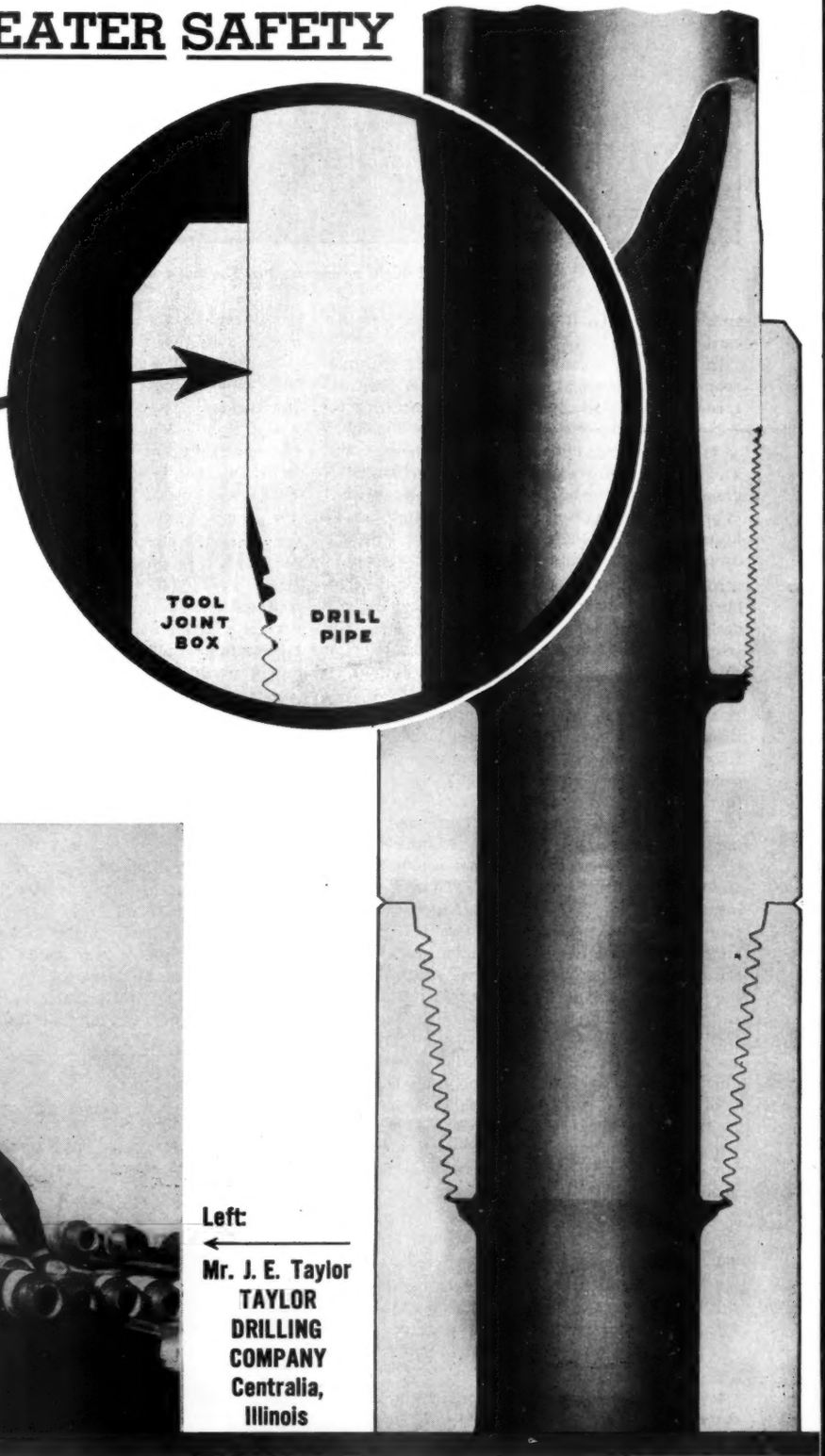


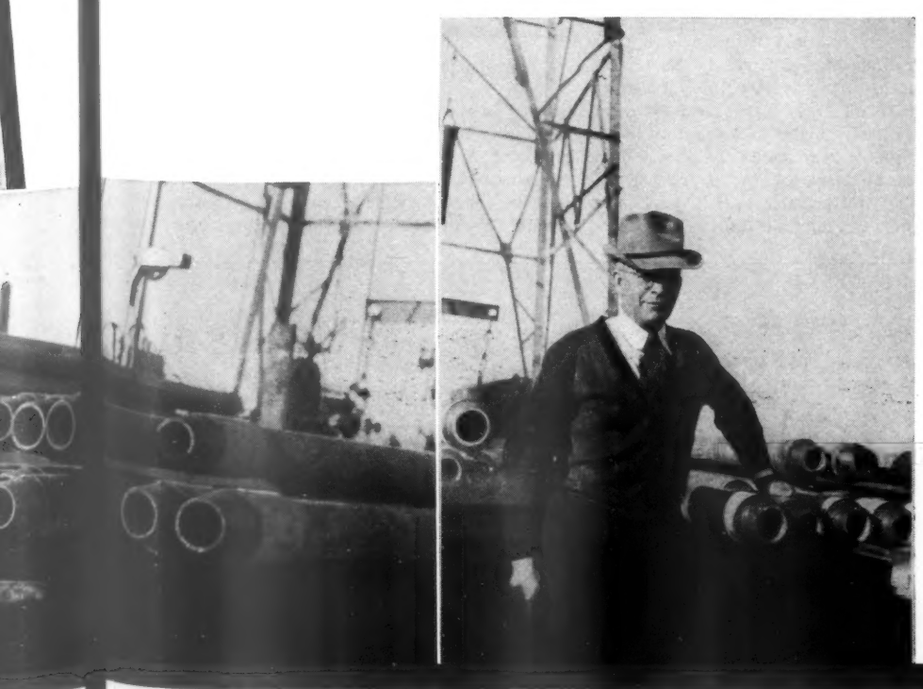

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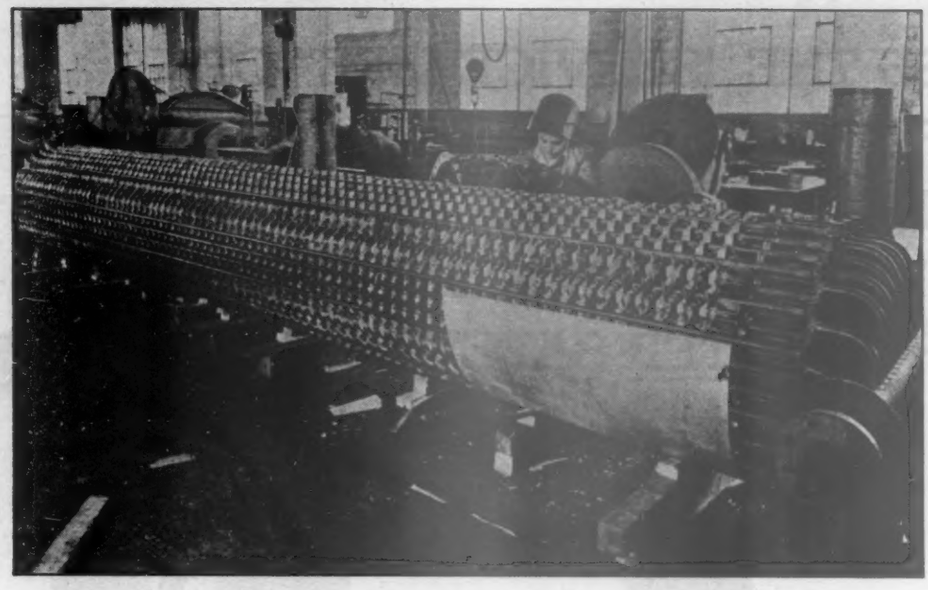

*Fig. 3—Tube and angle arrangement of Thermofor kiln proper*

and, consequently, it is common practice to discard it after 6 to 10 burnings.

In view of the many deficiencies of multiple-hearth kilns—particularly the fact that they degrade clays rapidly due to overheating, thus increasing percolation costs enormously—the lubricating-oil refining industry long has needed and sought for improved clay-burning methods. A great deal of efforts has been expended toward improving the performance of multiple-hearth kilns but, due to their inherently poor temperature control, only minor gains have been made.

After a careful fundamental study of clay-burning methods it was evident that a properly designed burner should embody means for the positive control of clay temperature and burning rate, with adequate provision for adding to or extracting heat from the system during operation. In view of the fact that an apparatus embodying these features had not been developed successfully, it was obvious that a new and novel approach would be required. It is the purpose of this paper to describe and submit to the petroleum industry the features, performance, operating characteristics, and application of a new clay-burning unit named the "Thermofor kiln," which has been developed on the basis of these requirements. This new unit embodies features of positive temperature control, burning rate, and heat transfer that make it suited admirably for the regeneration of percolation clays by treatment at high temperatures (900° to 1,200° F.). The application of the Thermofor kiln is not restricted solely to handling of clays, as there are numerous uses to which it might be applied in other industries for the treatment of finely divided solids under controlled conditions at high temperatures. In this respect the Thermofor kiln should find important commercial chemical-engineering applications beyond the scope of the petroleum industry.

The advantages of the Thermofor kiln over the conventional types of clay burners are summarized as follows:

1. Reactivation of clays to higher efficiencies and longer life than heretofore has been possible. This is accomplished by direct positive control of the burning temperature.

2. Low construction cost.

3. Low operating cost per ton of clay reactivated.

4. Excellent regeneration of clays by controlled partial combustion or "carbonization." Clays reactivated in this manner may be applied to distinct advantage in percolating solvent-refined oils. This type of regeneration is not practical with conventional types of clay burners.

5. Economical and practical clay burning on a comparatively small scale, particularly in plants in which clay is very expensive.

6. Ease of operation and reduced fire hazard.

The Thermofor kiln consists essentially of a stationary chamber containing vertical heat-transfer tubes, through which a heat-transfer medium flows. Figs. 2, 3, 4, and 5 illustrate the general arrangement and layout of a Thermofor kiln. In normal practice for burning clays the heat-transfer medium would consist of molten metal or salt, and it would be maintained at 850° to 1,500° F. The heat-transfer medium is pumped through the tubes to control the clay temperature by either removing or adding heat as needed. The heat-transfer tubes are surrounded by an interlaced structure of angle irons, which are stacked in such a manner that the tube bundle resembles a huge honeycomb of steel. These angle irons (see Figs. 2 and 3) are stacked with their apexes pointing upward, and each angle is perforated with several ports to provide for the passage of air. The air ports of each angle are located so that they open directly under a closed area of an intercepting angle iron immediately above. The functions of the angles are: (1) To provide the required burning-hearth surface; (2) to insure uniform clay flow through the kiln; (3) to provide air passages up through the clay; and, (4) to aid in the transfer of heat. A commercial Thermofor kiln of capacity of 50 tons per day weighs approximately 30,000 lb., and has an equivalent burning-hearth area of 1,800 sq. ft.

Reactivated percolation clays of greatly improved efficiencies have been produced consistently in both laboratory and plant development work. Many different types of experimental units—all involving similar principles of heat control—have been tested on the pilot-plant scale, with remarkably good results. A commercial unit of about 50 tons per day burning capacity now has been in continuous operation for 9 months on clays used for percolating typical Pennsylvania stocks. Several batches of clay now have been

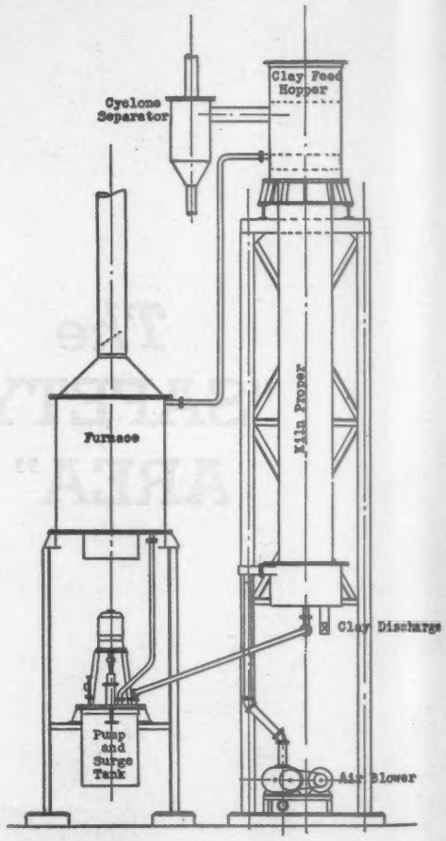


*Fig. 5—General layout of Thermofor kiln*

burned 16 cycles in this unit, and their efficiency has been maintained at an average of about 100 per cent during this period. Commercially regenerated clays from this unit also show similar high percolation yields when applied to a variety of Mid-Continent stocks. These results are illus-

*Fig. 4—Assembled Thermofor kiln ready for installation*

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trated in Fig. 6. Numerous other cyclic burning operations have given similar results.

Substantial savings in burning costs are obtained with the Thermofor kiln: because no outside fuel is required in regular operations, and the air consumption is low due to excellent combustion conditions. The oxygen content of the flue gases normally is less than 1 per cent. Fuel consumption—which is an appreciable item for conventional burners—is negligible with the Thermofor kiln, because the heat is obtained from burning of the adsorbed carbonaceous material. The only outside heat supplied is for bringing the burner up to temperature and for hardening of raw clays. Normally the heat needed is considerably less than the heat available from combustion of the carbonaceous material on the spent clay, and in some cases sufficient excess heat may be produced to justify recovery by auxiliary means. Another item contributing to lower operating costs is low maintenance, as there are no moving parts to the kiln proper. The 50-ton-per-day commercial unit mentioned hereinbefore showed no detectable wear nor corrosion, and required no repairs when inspected after 6 months' continuous operation.

As evidence of the close temperature control obtained with the Thermofor kiln, a chart is presented in Fig. 7 which illustrates that the temperatures can be maintained within very narrow limits even when the nature of the clay feed is altered drastically over short-time intervals. Further evidence of this precise control is illustrated in Fig. 8, which gives the actual operating-temperature curves for various clay zones in a kiln for a period of several hours during a full-scale commercial run.

As mentioned previously, the Thermofor kiln is an excellent type of apparatus for regenerating clays by controlled partial oxidation or other

**TABLE 1—COMPARISON OF THE PROPERTIES OF OILS PERCOLATED THROUGH CLAYS REGENERATED BY VARIOUS METHODS**

| Oil stock— | Clay No. | Method of reactivation— | Oxidation-susceptibility test*—Per cent volume of sludge after: 5 Days | 6 Days | 11 Days | 13 Days | 14 Days |
|---|---|---|---|---|---|---|---|
| Mid-Continent Duo-Sol-treated long residuum | Fresh | Burning | 10 | 14 | .. | .. | .. |
| | 7 | Burning | 6 | 10 | .. | .. | .. |
| | 3 | Carbonization | .. | 17 | .. | .. | .. |
| | 4 | Carbonization | .. | 10 | .. | .. | .. |
| Mid-Continent Duo-Sol-treated short residuum | Fresh | Burning | .. | .. | Nil | Nil | Nil |
| | 6 | Burning | .. | .. | Nil | Nil | Trace |
| | 5 | Carbonization | .. | .. | Nil | Nil | Nil |
| | 9 | Carbonization | .. | .. | Nil | Nil | Trace |
| Pennsylvania chlorex-treated neutral | Fresh | Burning | 4 | 6 | 13 | .. | .. |
| | 4 | Burning | 5 | 8 | 15 | .. | .. |
| | 3 | Carbonization | 5 | 6 | 13 | .. | .. |
| | 4 | Carbonization | 4 | 5 | 11 | .. | .. |
| Pennsylvania chlorex-treated long residuum | Fresh | Burning | .. | .. | Nil | Nil | Tar |
| | 2 | Burning | .. | .. | Nil | Nil | Trace |
| | 1 | Carbonization | .. | .. | Nil | Nil | Nil |
| | 2 | Carbonization | .. | .. | Nil | Nil | Tar |

| | | | Carbon residue | Slight‡ | Michie§ | Brown-Boveri turbine test† Neutral No. | Sludge |
|---|---|---|---|---|---|---|---|
| | | | (Per cent by weight) | | | | |
| Mid-Continent acid-treated neutral | 4 | Burning | .. | 21 | .. | .. | .. |
| | 4 | Carbonization | .. | 16 | .. | .. | .. |
| | 5 | Carbonization | .. | 18 | .. | .. | .. |
| Coastal acid-treated neutral | 2 | Burning | .. | .. | .. | 10 | 0 |
| | 3 | Burning | .. | .. | .. | 26 | 0 |
| | 2 | Carbonization | .. | .. | .. | 11 | 0 |
| | 6 | Carbonization | .. | .. | .. | 14 | 0 |
| Pennsylvania chlorex-treated long residuum | Fresh | Burning | 0.15 | .. | .. | .. | .. |
| | 2 | Burning | 0.18 | .. | .. | .. | .. |
| | 1 | Carbonization | 0.15 | .. | .. | .. | .. |
| | 2 | Carbonization | 0.14 | .. | .. | .. | .. |
| Pennsylvania short residuum | Fresh | Burning | 1.6 | .. | .. | .. | .. |
| | 4 | Burning | 1.3 | .. | .. | .. | .. |
| | 3 | Carbonization | 1.6 | .. | .. | .. | .. |
| | 5 | Carbonization | 1.3 | .. | .. | .. | .. |
| Pennsylvania neutral | Fresh | Burning | .. | 26 | 0.67 | .. | .. |
| | 4 | Burning | .. | 20 | 1.00 | .. | .. |
| | 2 | Carbonization | .. | 26 | 0.81 | .. | .. |
| | 6 | Carbonization | .. | 26 | 0.80 | .. | .. |

*Laboratory oxidation test at 350° F. with air passing over surface of sample in a glass beaker. Sample is stirred with iron stirrer at constant rate.
†H. Staeger, "Brown-Boveri Test," Brown Boveri Rev. 16, 92-7 (1929).
‡T. S. Sligh, Proc. Am. Soc. Testing Materials 27 (Part 1), 461 (1927).
§A. C. Michie, Bull. 148 British Standards Institution, April (1933).


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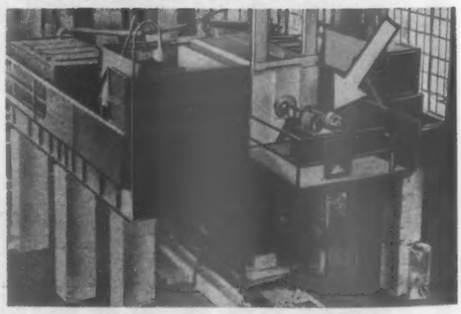

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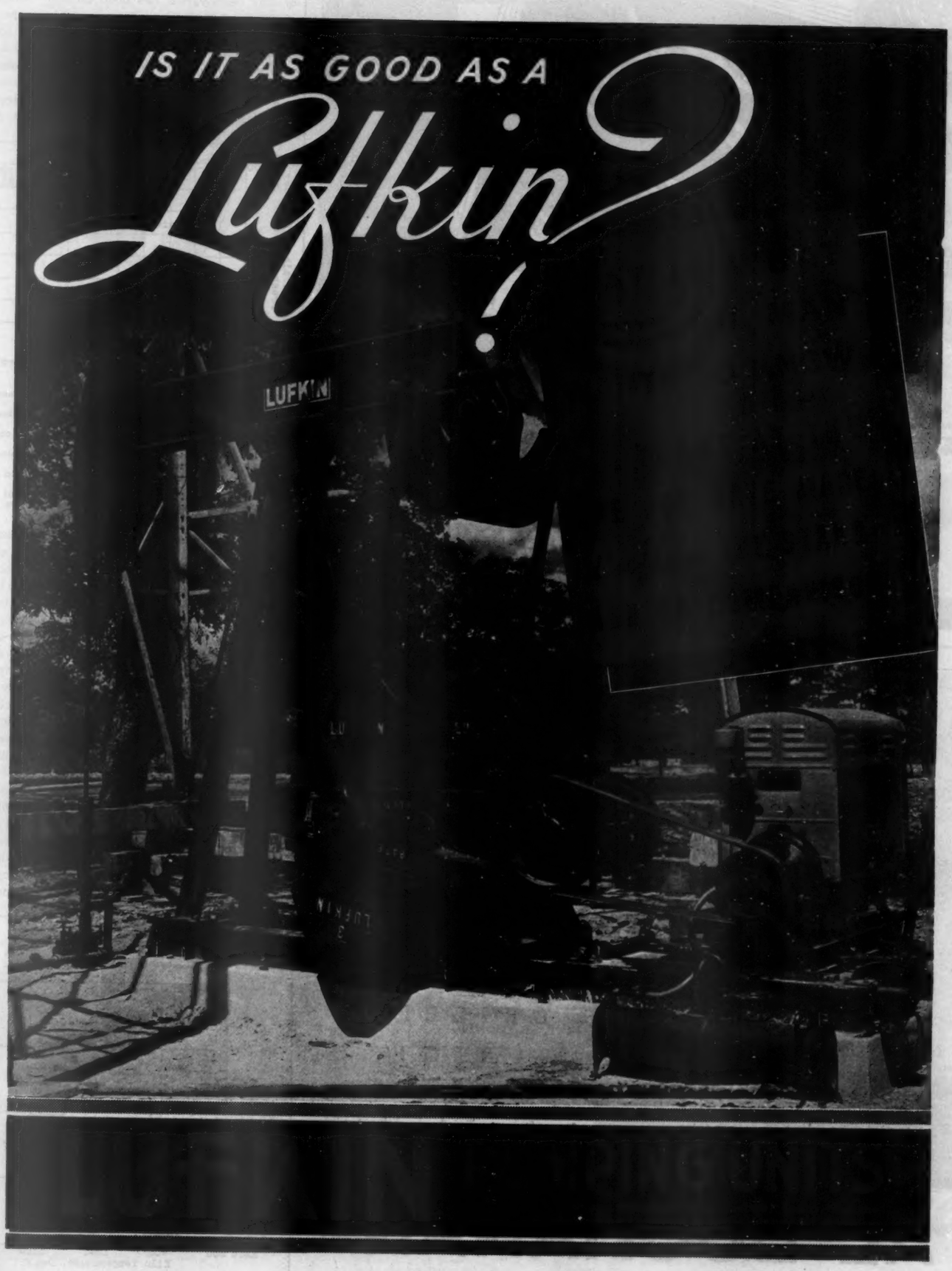
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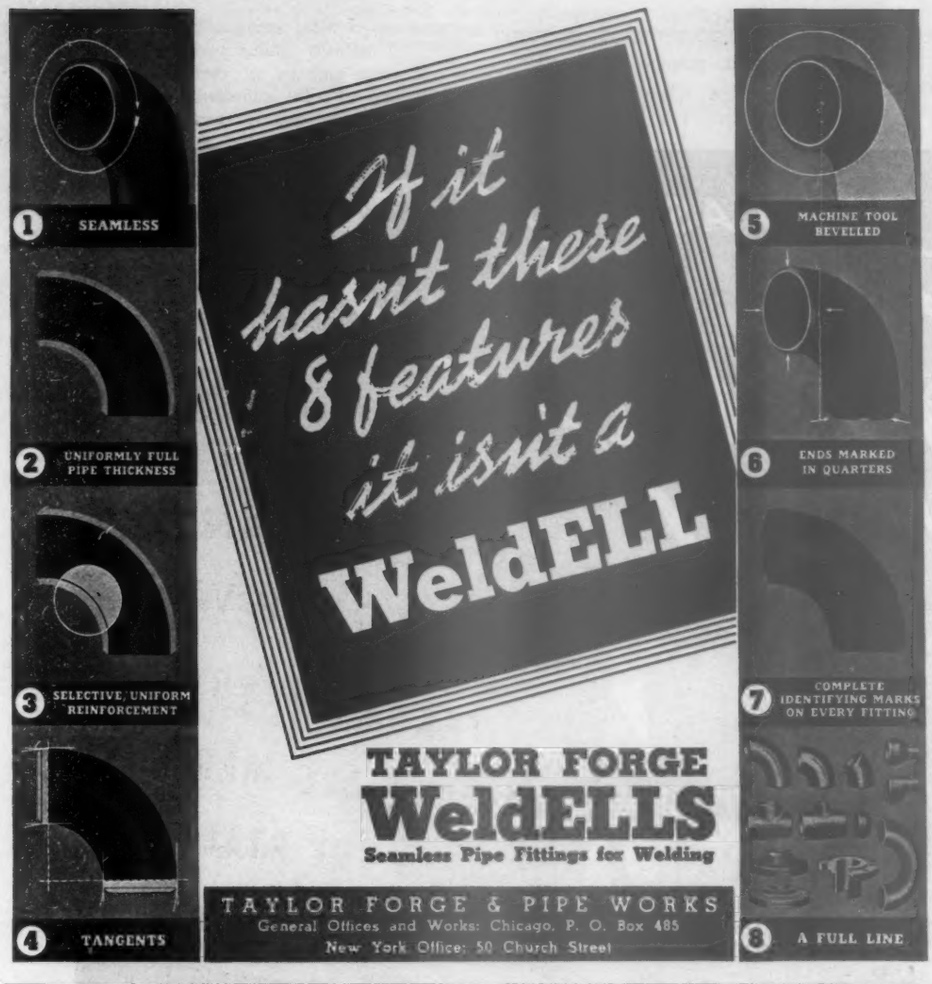
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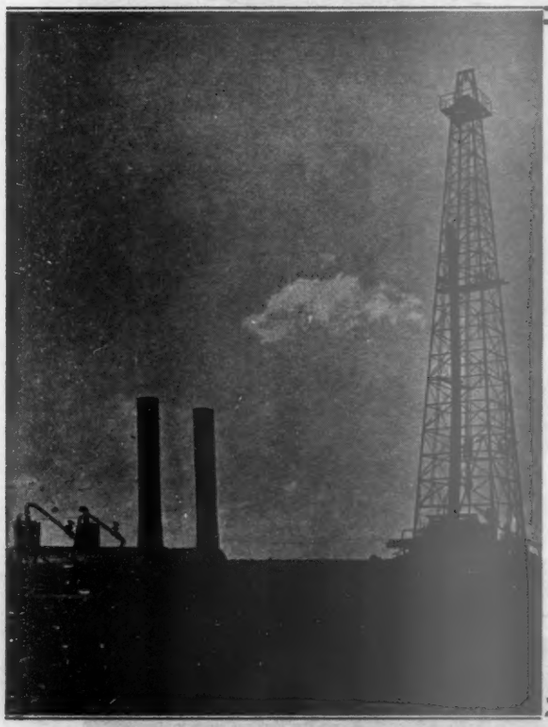

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treatment at high temperatures. Such operations may involve partial removal of the tarry deposits from the clay by oxidation or with substantially no oxidation. For the sake of simplicity, this type of clay reactivation has been termed "carbonization," to distinguish it from regular methods in which a much greater degree of oxidation occurs. In carbonization it appears that the heavy hydrocarbon molecules present on the clay decompose, forming an active carbonaceous deposit which has remarkably good adsorption characteristics for certain color bodies. Steam, inert gases, or reduced amounts of air may be passed through the clay to purge it during carbonization. In general yields on a volume basis, for clay reactivated in this manner, compare favorably with fresh burned clays. For some oils, notably Duo-Sol-treated and other solvent-refined stocks, the yields from clays reactivated by carbonization are from two to four times as high as from the same clays which have had the carbonaceous matter burned completely. Discarded clays which have an efficiency of 50 per cent, as compared with fresh clays, when regenerated in this manner will exhibit efficiencies nearly double that of fresh burned clay for filtering Duo-Sol-treated Mid-Continent stocks. With respect to solvent-refined oils, the high activity of clays reactivated by carbonization is not impaired to any marked extent with increased number of regenerations. Samples of clay reactivated in this manner 10 to 15 times exhibit efficiencies twice as high as those of freshly burned clays. In many instances clays of 300 per cent efficiency have been obtained. Curves illustrating the benefits of

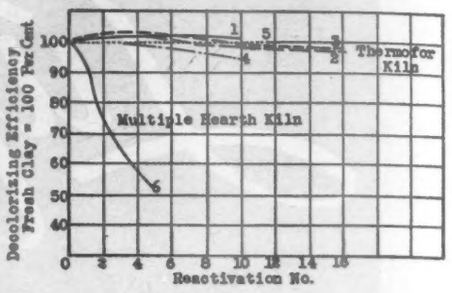


*Fig. 6—Decolorizing efficiencies of clays reactivated by burning in commercial kilns*

**Curve 1**—Laboratory percolations with Mid-Continent Duo-Sol-treated short residuum.
**Curve 2**—Plant percolations with Pennsylvania long and short residua, with and without chlorex treating.
**Curve 3**—Laboratory percolations as a check on plant percolations, Curve 2.
**Curve 4**—Laboratory percolations with Mid-Continent acid-treated short residuum.
**Curve 5**—Laboratory percolations with acid-treated coastal distillate.
**Curve 6**—Conventional operations on a variety of typical Pennsylvania stocks using plant-regenerated clays from a

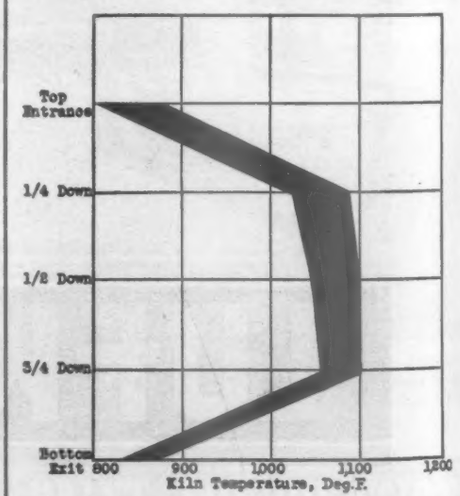


*Fig. 7—Temperature characteristics of Thermofor kiln when oil content of feed clay varied from 0 to 5 per cent at 30-minute intervals with clay turnover in kiln once each hour*

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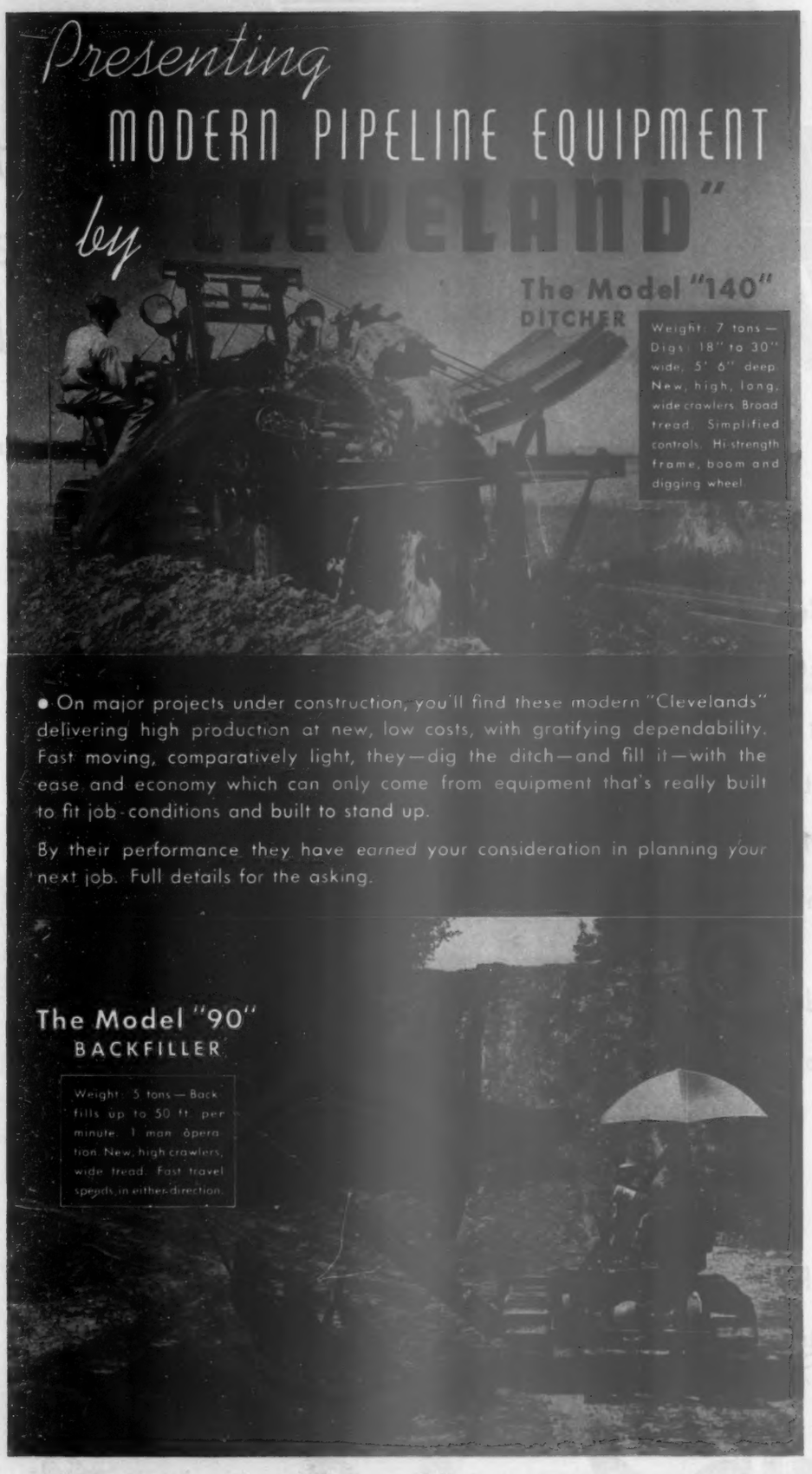
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carbonizing operations are given in Fig. 9.

Oils percolated through clays which have been reactivated by carbonization have almost identical properties to those filtered through completely

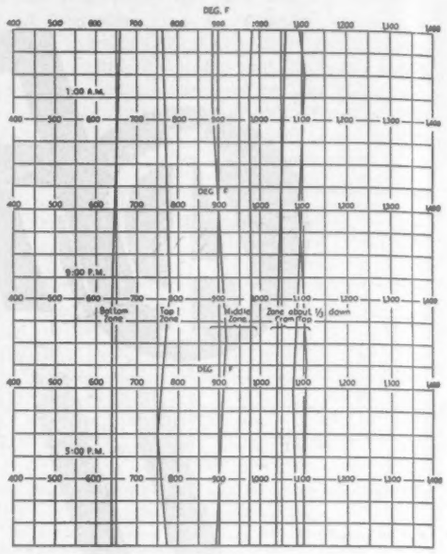


*Fig. 8—Temperature chart of commercial Thermofor kiln with a clay rate of 21 lb. per hour per cubic foot of kiln volume and 7.2 per cent of carbonaceous material on unburned clay*

burned clays. Proof of this is apparent from Table 1.

In typical lubricating-oil decolorizing operations the advantages of the Thermofor kiln outlined above result in large savings in expenses for fresh clay, clay handling, filter washing, filter blowing, solution distillation, wash-oil handling, clay burning, clay disposal, maintenance, oil losses, and oil degradation. These savings are magnified further in the case of many solvent-refined oils having good response to clays regenerated by carbonization. Economic calculations for three typical lubricating-oil refineries—one on 100 per cent Pennsylvania crude, a second on Mid-Continent and Gulf coastal crudes using both acid and solvent refining, and a third on Mid-Continent crude using almost 100 per cent solvent refining—show that Thermofor kilns give very quick investment retirements. Conservative estimates show payouts of 1 to 2 years for equipment investment plus

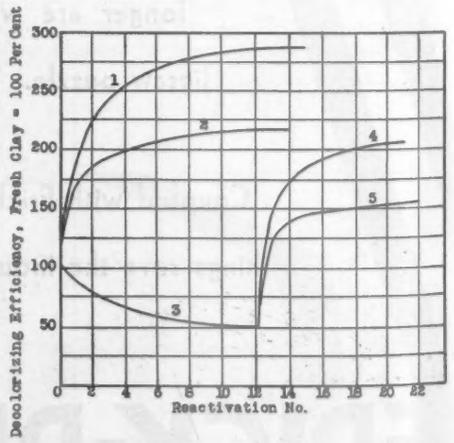


*Fig. 9—Efficiency of clay reactivated by carbonization for decolorizing Mid-Continent Duo-Sol-treated oils*

*Curve 1*—Carbonized clay, Mid-Continent Duo-Sol-treated short residuum.

*Curve 2*—Carbonized clay, Mid-Continent Duo-Sol-treated long residuum.

*Curve 3*—Multiple-hearth burned clay, Mid-Continent Duo-Sol-treated long and short residua.

*Curve 4*—Carbonization cycles starting with No. 12 multiple-hearth clay, Mid-Continent Duo-Sol-treated short residuum.

*Curve 5*—Carbonization cycles starting with No. 12 multiple-hearth clay, Mid-Continent Duo-Sol-treated long residuum.

paid-up royalty; and, in cases in which running royalties are employed, payouts of less than a year are indicated.

Thermofor kilns are attractive for large and small-scale installations. Two commercial units are now actually in operation, one having a capacity of 50 tons per day and another 10 tons per day. A third unit of 120-tons-per-day capacity is under construction, and will be placed in operation in the near future. The equipment investments for commercial units with necessary auxiliary feed hoppers and temperature-control devices, but exclusive of clay conveyors, will be 25 to 50 per cent less than those for multiple-hearth installations handling the required amount of clay to give the same decolorizing capacity. Burners as low as 10-tons-per-day capacity can be built without any serious disadvantage in price due to smallness.

Another important advantage of the Thermofor kiln is that its installation automatically increases percolation-plant capacity by a substantial proportion. For example, in a typical refinery in which clay is regenerated and segregated 10 times and is discarded after the tenth cycle, the average clay efficiency for the entire plant is only 66 per cent based on fresh clay. With a Thermofor kiln in operation and fresh clay being added only to make up for losses (2 per cent per cycle assumed) the clay efficiency of the same plant can be maintained at an average of 95 per cent. This increase in clay efficiency reduces the washing, loading, and unloading time on the filters by 30 per cent of the normal requirement, and increases proportionately the time for percolation. In this particular case the gain in percolation time represents a 15 per cent increase in the overall filter-plant capacity.

# Estimating Soil Corrosivity

*(Continued from Page 138)*

pared, and a variable current from an outside source is applied between the electrodes.

Denison proposes to determine the corrosivity of soil series or types rather than the corrosivity of individual samples, and for one pipe line has shown that he was able correctly to classify the

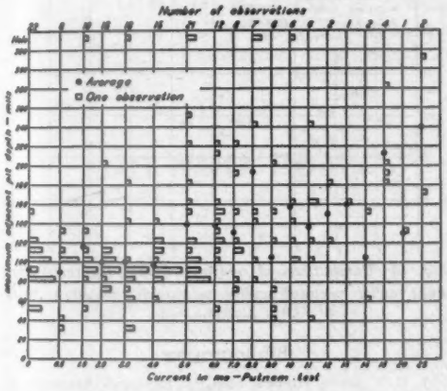


*Fig. 15—Relation between the results of the Putnam test and maximum pit depths*

soils along 80 per cent of the line with respect to their corrosiveness. However, for the present purpose the results of tests of individual samples of soils by all methods have been compared with the maximum pits on the sections of pipe adjacent to the samples. The effect of treating the results of the tests in another way will be presented later.

The Denison test requires somewhat more care in the preparation of the soil samples than is required by the other tests, and slight errors in the manipulation of the test may cause large errors in the results. For this reason the test was run in duplicate, and re-run if the results did not check within 20 per cent. In addition, the tests were repeated on soils for which the dispersion of the data was unusually large. It is possible that the simplicity of the other tests renders their duplication less necessary. However, the repetition of the Denison tests naturally would yield results more truly representative of the method than those obtained from single trials of the other methods. For this reason the results of the Denison test should be regarded as a demonstration of what can be done with this method rather than of its merits in comparison with the other methods.

Fig. 17 shows the relation between the average current densities obtained from the Denison test and the maximum pit depths on the joints of pipe adjacent to the soil samples. The distribution of the averages of the pit depths associated with each current density is similar to the distribution of corresponding data for the other tests.

**Summary of correlations of tests with pit depths.**

It would be difficult to determine by inspection of Figs. 8 to 17 which test was the best indicator of the corrosiveness of the soil. The use of a linear scale for the abscissae of Figs. 6 to 17 was incompatible with the presentation of the data for individual pit depths in a compact form. The nonlinear forms make it difficult to compare the figures. The averages of the data for each figure, therefore, have been replotted to linear scales in

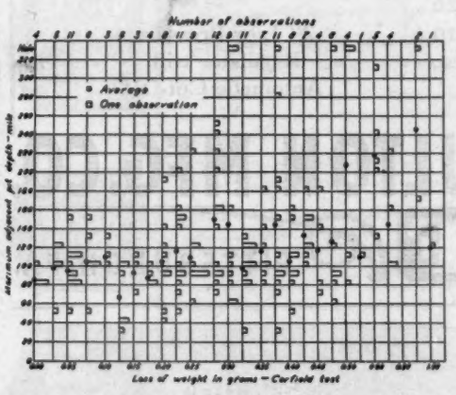


*Fig. 16—Relation between the results of the nipple-and-can test and maximum pit depths*

Figs. 18 and 19. The scales have been chosen so that the lengths of the abscissae for all of the curves are approximately the same. The figures indicate that there is not a great deal of difference in the degree of correlation of the results of most of the tests with pit depths. It would be possible to derive equations which approximately represent each set of data, and to compute the correlation coefficients or some other criteria for the goodness of fit of the data. Such a procedure might show that one test was superior to the others. It is doubtful, however, whether the information which might be obtained in this way would justify the labor required to obtain it. The most important conclusions from this treatment of the data are that, when treated in the ways described, the results are similar. All methods show in a very general way the corrosiveness of the soil samples; but whenever several test results having the same value were obtained, widely divergent pit depths are associated with them. There appears to be no fixed relation between the results of the tests and the maximum pit on the joint of the pipe line nearest the sample tested. This may be due to the inadequacy of the tests, the improper sampling of the soil, or the unrepresentative character of the pit depth chosen as the indication of the corrosiveness of the soil.

### The Effect of Grouping the Data on the Interpretation of the Results of Soil Tests

Although tests of individual samples of soil do not indicate with sufficient accuracy the corrosion to be expected on a pipe line in the vicinity of the sample, it is reasonable to suppose that the average value of the corrosiveness of soil types or series obtained by averaging the results of laboratory tests by a given method might be correlated with the average corrosiveness of the soil as measured by averaging the maximum pit depths on sections of the pipe. It has been shown previously that soils differ widely in corrosiveness. If by means of tests the soil types could be arranged in the approximate order of their corrosiveness, the purpose of a soil-corrosion survey would be fulfilled. This method has been followed by Ewing[3] and Denison.[4]

In order to study the correlations between the corrosiveness of the soil types as indicated by the results of the soil-corrosion tests and the corrosiveness as indicated by pit measurements, the soils were divided into five arbitrary groups, which were based on the depth of the average maximum pit in the various soils. The limiting values in each group are given in Table 1, together with the corresponding limiting values for each of the test methods. These latter values were obtained by plotting the results by each test method against pit depth. Table 2 shows the data with which comparisons of the corrosivity tests will be made.

From Tables 1 and 2, Table 3 was derived. Table 3 shows the soil-corrosivity group to which each soil series is assigned by the pit depths on the line and by each method of test.

Tables 4 and 5 show how nearly the results of the tests agree with the pit depths in the assignment of the soils to the corrosivity groups. A zero indicates perfect agreement between pit depth

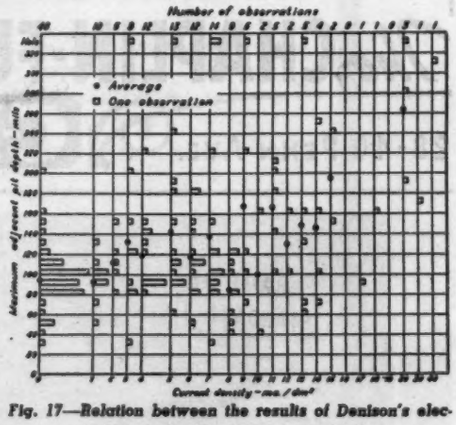


*Fig. 17—Relation between the results of Denison's electrolytic test and maximum pit depths*

and test data as to the group to which the soil series belongs. A minus sign indicates that the test underestimates the corrosivity of the soil. The number following the plus or minus sign shows how large was the error in terms of corrosivity groups.

Tables 4 and 5 together show eight ways of estimating the accuracies of the tests. No test failed to classify correctly at least one of the soils on one of the two bases of selecting the pit depths, but no test correctly determined the corrosivity of every soil series on either basis. These tables indicate that each test is better adapted to the determination of the corrosivity of some soil series than of others. It follows that the relative accuracies of the tests might appear different if data from a pipe line in some other part of the country were used.

Inasmuch as the percentage of correct identification of the corrosivity of soil series by either the acidity-resistivity method or Denison's method

are as high as those attained by these methods when leaks and reconditioning were used as criteria of soil corrosivity.[3,4] It appears that maximum pit depths must be an equally good criterion of soil corrosivity.

The relative values of the tests as they are indicated in Tables 4 and 5 depend on the arbitrary limits selected for the pit depths which define the five corrosivity groups. This objection has been overcome in Table 6, which shows the relative merits of the test methods on the basis of the success with which the tests assign each of the several soil series in the rank or order of their corrosiveness. In this table the relative merits of the tests are different from those shown in Tables 4 and 5. It is largely a matter of opinion as to which basis of comparison is the more advantageous. The significant point is that several methods of determining the corrosivity of soils are of definite value. Probably no one is the most suitable for all conditions.

## Conclusion

It has been shown that none of the soil-corrosivity tests studied may be used in predicting the depth of the deepest pit which may occur in the neighborhood of the soil sample. However, if a soil survey is made and a representative number of samples of each soil series is taken, the average corrosiveness of soil series can be determined with a reasonable degree of accuracy by any one of several of the tests which have been compared. It is not possible to establish definitely which test is the most accurate, because the apparent relative merits of the tests depend on the basis upon which they are compared. As the relative merits of the tests differ for different soil series, the tests would not be equally well suited for all parts of the country. The test best suited for the regions containing alkali soils might not be the best for regions containing heavy, wet, and organic soils.


## Acknowledgments

The authors are indebted to I. A. Denison, S. P. Ewing, and W. H. Johnson for suggestions regarding the conduct of the tests and the interpretation of the data.

Messrs. W. H. Johnson, M. Romanoff, U. Funaroff, and D. Fickle spent many hours in the calculation of the data and the drawing of figures.


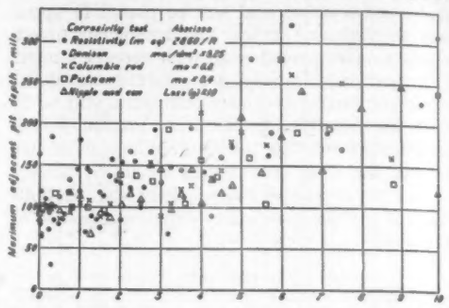


*Fig. 18—Comparison of average values for resistivity, Denison, Columbia rod, Putnam, and nipple-and-can tests with maximum pits*

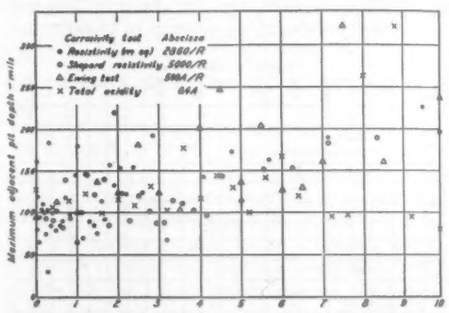


*Fig. 19—Comparison of average values for resistivity, field resistivity, total acidity, and acidity-resistivity tests with maximum pits*

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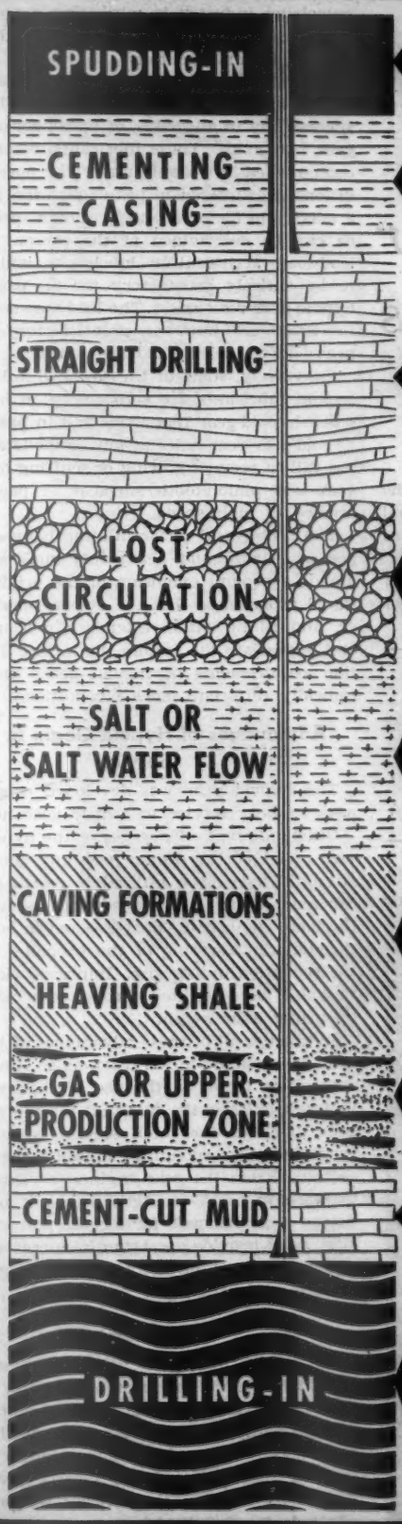


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ZEOGEL—A concentrated colloidal clay which forms a gel with salt water. Yields upwards of 100 barrels of mud per ton in brine. Can be used where nothing but salt water is available.

BAROID or COLOX—Drilling mud weighting materials. Muds suitably weighted with BAROID or COLOX counterbalance pressure of salt water flows. Can be added to native mud or mixed straight with water and AQUAGEL.

**AQUAGEL BAROID COLOX STABILITE**

AQUAGEL—Enough should be added to the mud to produce superior wall-building qualities and keep the cake thin. This will reduce greatly the tendency of formations to cave.

BAROID or COLOX—Suitably weighted muds have demonstrated their efficiency in holding caving or heaving formations in place.

STABILITE—There are several formulas of STABILITE, both liquid and dry, the choice of which depends upon the condition of and contaminating materials in the mud at the time treatment is required. Reduces viscosity and gel-strength and improves walling qualities.

**STABILITE BAROID COLOX AQUAGEL**

STABILITE—Reduces danger of blowouts by freeing entrained gas, thereby keeping mud weight constant.

BAROID or COLOX—Highly weighted muds are frequently necessary to confine gas or other pressures.

AQUAGEL—Sufficient should be carried in all muds to keep the water loss low and the cake thin.

**SMENTOX**

SMENTOX—When drilling ahead after a cement job, the use of SMENTOX counteracts the effects of cement on mud. A small amount added to mud after a cement job will often eliminate the necessity of discarding the mud. Viscosity is reduced and wall-building qualities restored.

**AQUAGEL BAROID COLOX STABILITE**

AQUAGEL—In Low-Pressure Areas—Straight AQUAGEL-water mud (5½% to 7% by weight depending upon the mixing water used) is the ideal mud for drilling in. The low water loss keeps water from the oil sands and the thin cake is quickly and easily removed. Wells drilled in with this fluid swab on production and clean up quicker.

BAROID or COLOX—In High-Pressure Areas—A combination of BAROID or COLOX and AQUAGEL made up to suitable weight is the ideal drilling fluid. In locations where the natural mud provides adequate walling qualities BAROID or COLOX added to the mud in sufficient quantities will provide adequate weight to insure safety.

STABILITE—If gas cutting of the mud occurs, add suitable quantities of STABILITE in either liquid or powdered form.

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# Hypoid-Lubricant Requirements

## . . . for passenger-car and truck rear axles

By H. R. WOLF
General Motors Research Laboratories, Detroit, Mich.

THE recent use of hypoid gears in heavy-duty truck rear axles has introduced a new problem in hypoid-gear lubrication.

Truck hypoid gears do not differ fundamentally in design from passenger-car hypoid gears, but they operate under somewhat different service conditions and, therefore, may require a different type of lubricant to prevent scoring and scuffing of the gear-tooth surfaces.

A passenger-car hypoid-gear axle operates under the most severe lubrication conditions at high speed, whereas a heavy-duty-truck hypoid axle operates under the most severe lubrication conditions at low speed with maximum engine torque in low gear.

Hypoid gears have been used in passenger-car rear axles since 1926.[1] Prior to 1936 they were used by only a limited number of automobile manufacturers. The lubrication of these axles did not present a serious problem to the petroleum industry. Approved lubricants, largely of the lead-soap active-sulfur type, were handled by the authorized car dealers and service stations, and no attempt was made to market a hypoid lubricant through the filling stations.

In 1936 hypoid gears were adopted for quantity production by a large number of passenger-car manufacturers. This widespread use of hypoid-gear axles made it necessary quickly to expand the sources of supply for hypoid lubricants. The success of the whole program, and the almost complete absence of service failures or complaints was due to: (1) The extensive educational campaign carried out by both the automotive and petroleum industries; (2) the cooperation of the petroleum industry in marketing a powerful extreme-pressure or hypoid lubricant through all retail lubrication outlets.

**A.P.I.** — Presented before annual meeting, Chicago, Ill., November 13-17, 1939

*Fig. 1—Rear-axle dynamometer*

Lead-soap active-sulfur hypoid lubricants have been distributed widely, and have been used successfully in all makes of passenger-car hypoid-gear rear axles. These lubricants, when properly compounded, are stable under the operating conditions encountered in passenger cars, and afford a maximum factor of safety at high speed. As far as can be determined at the present time, the lead-soap active-sulfur lubricants will continue to be entirely satisfactory for all passenger-car hypoid-gear rear axles. The lead-soap active-sulfur lubricants are, however, unsatisfactory for use in heavy-duty truck hypoid-gear axles.

Conversely, some of the so-called mild types of hypoid lubricants are satisfactory in heavy-duty-truck hypoid-gear rear axles and in passenger-car hypoid-gear rear axles at low or moderate speeds, but fail to prevent scoring or scuffing of the ring-gear and pinion-tooth surfaces in passenger-car service at high speed.

The problem of differentiating between passenger-car service and heavy-duty-truck service demands a prompt extension of the original educational program so that the owner, operator, dealer, and filling-station attendant will understand and appreciate the factors that affect the lubrication requirements of hypoid gears under these radically different service conditions.

### Advantages of Hypoid Gears in Truck Service

The hypoid gear was developed originally for passenger-car service to reduce gear noise.[2]

Other inherent advantages of the hypoid gear,[3] viz., offset of the pinion gear and greater tooth strength, have been utilized in recent passenger-car axle designs. These advantages have given the body engineer greater freedom in body design through the lowering of the propeller shaft and the reduction in axle size. Improved riding qualities also have resulted through the reduction in unsprung axle weight.

Indirectly, all of these advantages of the hypoid gear are retained in the truck axle. However, the controlling factor in the use of the hypoid gear in truck axles is the fact that for the same ring-gear diameter the tooth section is far stronger than the corresponding spiral-bevel-gear tooth section. From the gear engineer's viewpoint this increase in tooth strength makes it possible to design a smaller axle for a given power transmission, or to provide a substantial increase in factor of safety in axle life without increasing the overall axle size or weight.

### Nomenclature

Obviously, inasmuch as some passenger-car hypoid lubricants are unsuited for use in heavy-duty trucks and some truck hypoid lubricants are unsatisfactory in passenger-car hypoid axles at high speed, a standard nomenclature must be evolved that will indicate clearly the type of service for which each lubricant is adapted. All of the factors involved in passenger-car and truck hypoid-gear lubrication clearly must be recognized.

Such terms as active, corrosive, inactive, non-corrosive, mild, high speed, high load, or high torque have been proposed. These terms focus attention on one property of the lubricant without evaluating this property and, more important, without indicating to the user whether the lubricant is satisfactory or unsatisfactory for use in a particular rear axle.

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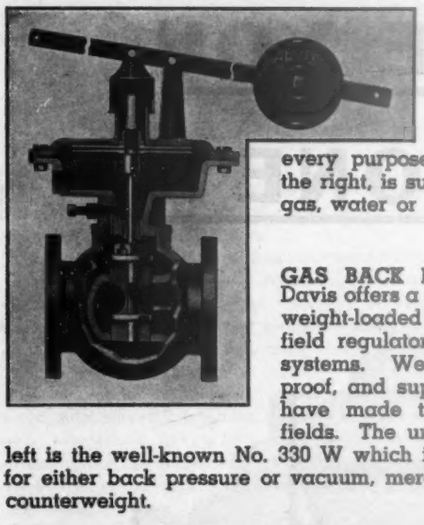

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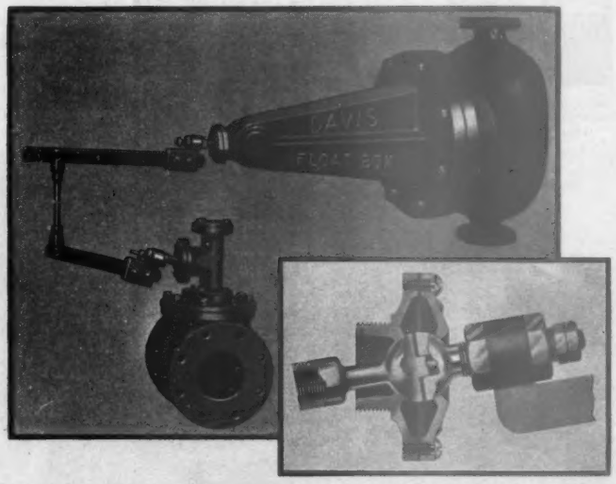


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more definitely to the station operator and car owner the suitability of a particular lubricant for a specific use, a number of automobile manufacturers have adopted the following nomenclature:

"Passenger-car-duty hypoid lubricant," and
"Truck-duty hypoid lubricant."

The word "duty" was included in the nomenclature in order to emphasize the fact that the operating conditions, and not the type of vehicle alone, must be considered in selecting a rear-axle lubricant. A light-duty commercial car or truck built on a passenger-car chassis, and operating essentially under passenger-car conditions, may require a "passenger-car-duty hypoid lubricant" rather than a "truck-duty hypoid lubricant."

Some lubricants may qualify as "truck-duty hypoid lubricants" for use in all heavy-duty hypoid-gear truck axles and as "passenger-car-duty hypoid lubricants" for use in certain passenger cars, but may be entirely inadequate for use in other passenger cars at high speed. Such lubricants could not be classified properly as "passenger-car-duty hypoid lubricants" for universal distribution and marketing in the passenger-car field.

### Universal or Dual-Purpose Gear Lubricant

The need for simplifying recommendations for transmission and rear-axle lubrication, and the desirability of marketing fewer gear lubricants, have been presented in a number of technical papers,[9,4] and have been discussed by the S.A.E. subdivision on transmission and rear-axle lubricants.

A reduction in the number of gear lubricants required, obviously, will benefit the oil industry in eliminating unnecessary stocks and, from the automotive industries' viewpoint, minimize the possibility of confusion in the service field. A single gear lubricant may be the ultimate answer to the gear-lubrication problem; however, it must be remembered that such a lubricant cannot be a compromise, but must meet fully the lubrication requirements under all operating conditions in all units in which its use is recommended.

Applied specifically to the passenger-car and truck hypoid-axle problem, a universal or dual-purpose hypoid lubricant must lubricate properly all makes and models of passenger-car hypoid axles under the most severe high-speed driving conditions, and at the same time must lubricate satisfactorily all makes and models of heavy-duty-truck hypoid axles under the most severe operating conditions existing at low road speed with full torque through low gear.

A hypoid lubricant—even though it may be capable of lubricating a complete line of passenger-car and truck hypoid axles—produced by a single automotive manufacturer cannot be distributed universally as a dual-purpose hypoid lubricant unless it is also capable of lubricating all other makes of passenger-car and heavy-duty-truck hypoid axles under all service conditions.

### Marketing Problem

Many refiners and marketers now carry three gear lubricants:

1. A mineral gear oil.
2. A mild extreme-pressure gear lubricant.
3. A powerful extreme-pressure or hypoid lubricant.

Some refiners have discontinued the mineral gear oils in all except the heavier grade (S.A.E. 250) used in spiral-bevel-gear heavy-duty-truck axles; and market, for general distribution, through the filling stations:

(*a*) A mild extreme-pressure gear oil, for use in transmissions and in the older models of passenger cars equipped with spiral-bevel-gear axles.

(*b*) A powerful extreme-pressure or hypoid lubricant for use in all passenger-car hypoid gear axles and in some passenger-car models equipped with highly stressed spiral-bevel gears.

To those marketers who prefer to continue with either two or three gear lubricants, it would appear that two courses are open.

One solution would be to retain the present lead-soap active-sulfur lubricant as a "passenger-car-duty hypoid lubricant," and to modify the mild EP lubricant, now used as a transmission lubricant and as a rear-axle lubricant in some of the older models equipped with spiral-bevel gears, to make it suitable for both passenger-car transmissions and heavy-duty-truck hypoid rear axles. These modified lubricants could be classified as a "transmission and truck-duty hypoid lubricant," and in connection with the lead-soap active-sulfur "passenger-car-duty hypoid lubricant" would enable the car dealer and filling station adequately and safely to service all transmissions and rear axles.

The second solution would be to retain the present mild EP lubricant for use in transmissions and in spiral-bevel axles that do not require a hypoid lubricant, and to replace the present lead-soap active-sulfur hypoid lubricant with a lubricant that will lubricate satisfactorily all passenger-car and all truck hypoid axles under all operating conditions. This new lubricant could be classified both as a "passenger-car-duty hypoid lubricant" and as a "truck-duty hypoid lubricant."

However, it should be emphasized again that a lubricant intended for universal use in both passenger-car and truck hypoid axles cannot be a compromise, but must lubricate adequately and prevent scoring or scuffing of the gear-tooth surfaces in all makes and models of passenger cars and trucks under all operating conditions.

The automotive manufacturers are not attempting to direct the development along either line, or to specify the type or composition of hypoid lubricants for use in service. They are trying only to point out the problem as it affects their own products, in order that the petroleum industry will be in a position to supply to the trade the necessary lubricant or lubricants required properly to service both passenger cars and trucks under all field conditions under which they may be operated.

### General Motors Hypoid Specifications

With the hypoid-gear axle originally was adopted by several car divisions of General Motors Corp. for production in the 1937 models, hypoid lubricants were not distributed generally by the petroleum industry, and were not readily available to the car dealers nor individual owners.

In order to protect the car owners and to provide adequate distribution of a satisfactory hypoid lubricant, the car divisions made available to General Motors dealers, through General Motors Parts Corp., the same type of lubricant as was used in production for the initial filling.

This merchandizing of hypoid lubricants was only a temporary expedient, and was discontinued by the corporation as soon as distribution was effected by the petroleum industry and hypoid lubricants became available to the dealers through their regular sources of supply. However, further to safeguard the car owner and dealer during this transition period, it was necessary to establish an approved list of hypoid lubricants.

As soon as laboratory tests could be correlated with performance in service, specifications were issued, and the approved lists were discontinued. The first group of specifications issued under date of July 1937 covered the types of lubricants used by the car divisions for original servicing of passenger-car hypoid axles. These specifications, although intended primarily to cover factory purchases, were viewed by the trade in general as a recommendation for specific lubricants meeting these chemical and physical requirements, and a disapproval of all other types of lubricants regardless of their properties or service records. In order to correct this impression, and as it obviously was impossible to cover all future commercial developments, revised specifications—based entirely upon general requirements and axle-performance tests—were issued under date of July 1939.

Pars. 1 and 2 of this revision (July 1939) constitute the complete specification for passenger-car hypoid lubricants. A lubricant meeting these requirements, regardless of composition, may be considered satisfactory for original filling or for use in service. The detailed chemical and physical requirements outlined under the individual specification numbers, as noted in Par. 3, cover specific types on which laboratory tests have been correlated with service performance. These detailed specifications are intended primarily as a convenience in inspecting lubricants purchased by the car divisions for initial filling. All of the types covered by the detailed chemical and physical specifications meet the minimum requirements of Pars. 1 and 2, but they do not possess necessarily the same factor of safety under actual service conditions.

Lubricants meeting the requirements of the General Motors specifications, therefore, may be classified as "passenger-car-duty hypoid lubricants" for use in past and current models of General Motors passenger cars. However, as the lubrication requirements of an axle depend upon the gear design and operating conditions, a specific lubricant—even though it meets the performance tests outlined in Par. 2, or one of the detailed chemical and physical specifications—may not be satisfactory in axles built by other automobile manufacturers. Each car manufacturer must formulate his own specifications, based entirely upon the lubrication requirements of his particular axle.

The General Motors specifications for hypoid lubricants (July 1939) were issued before heavy-duty trucks employing hypoid axles were mark-


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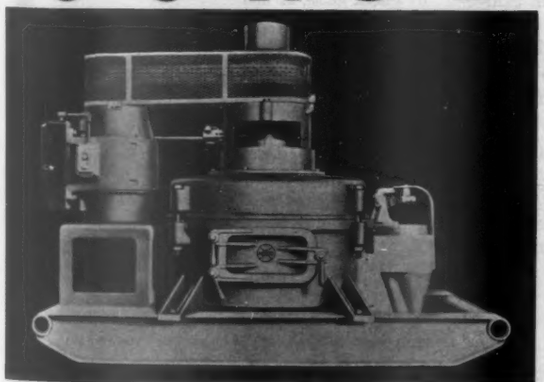

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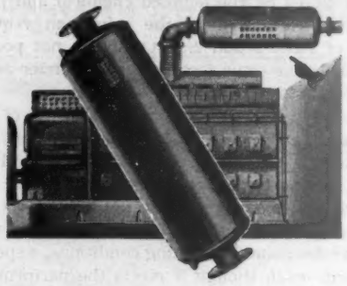

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eted by the corporation. However, primarily tests indicate that several of the lubricants covered by these specifications may be classified also, insofar as current General Motors requirements are concerned, as "truck-duty hypoid lubricants," as well as "passenger-car-duty hypoid lubricants." Again these lubricants may be unsatisfactory in other makes of truck axles; and before a lubricant can be marketed for general distribution as either a "passenger-car-duty hypoid lubricant" or a "truck-duty hypoid lubricant," the lubricant manufacturer must assure himself that his lubricant or lubricants will function satisfactorily in all makes of either or both passenger-car and truck hypoid axles.

Although a "truck-duty hypoid lubricant" that also will qualify as a "passenger-car-duty hppoid lubricant" may offer a marketing advantage, it is not required that a lubricant which will perform satisfactorily in the Chevrolet 1½ ton truck shall meet also the requirements of the General Motors specifications for passenger-car hypoid lubricants. However, such a lubricant, of course, must be branded properly so that its use will be restricted to the heavy-duty truck.

Until more complete data are available from the field on the performance of the different types of hypoid lubricants in the heavy-duty-truck axle under actual service conditions in the hands of operators, separate specifications will not be issued by the General Motors Corp. on "truck-duty hypoid lubricants." The selection of lubricants for initial factory filling will be based largely on performance in the axle dynamometer test described under "tests on passenger-car and truck hypoid lubricants, herein." When and if it becomes necessary to issue separate truck hypoid-lubricant specifications, these specifications, like the present passenger-car hypoid-lubricant specifications, will be based on axle performance under service conditions; and the detailed physical and chemical requirements will be given only for the convenience of the manufacturing divisions in purchasing lubricants for initial servicing.

### Tests on Passenger-Car and Truck Hypoid Lubricants

A number of hypoid lubricants have been evaluated, for passenger-car and truck service, by our research laboratories in cooperation with the several car divisions of General Motors Corp. The analytical data on these lubricants are given in Table 1.

TABLE 1—COMPOSITION OF LUBRICANTS USED IN AXLE TESTS

| Lubricant | Lead soap calculated as lead oxide | Total Saponifiable | Total sulfur | Total chlorine | Saybolt viscosity at 210 deg. F. |
|---|---|---|---|---|---|
| A | 1.86 | * | 4.19 | nil | 83 |
| B | 1.31 | 25.78 | 1.69 | 1.10 | 113 |
| C | nil | nil | 1.20 | 3.20 | 81 |
| D | nil | nil | 1.60 | 2.80 | 80 |
| E | nil | nil | 0.12 | 2.79 | 68 |
| F | nil | 11.4 | 1.42 | nil | 91 |
| G | nil | 46.5 | 5.26 | nil | 84 |

*Present in lead soap.

These lubricants were evaluated for passenger-car duty in Chevrolet 1939 passenger cars, on the road, under the test procedure outlined in Table 2. This test generally is referred to as the "Chevrolet or proving-ground axle test." and is the performance test specified in Par. 2 of the General Motors specifications (July 1939) for passenger-car hypoid lubricants.

These lubricants were evaluated also for truck duty in a Chevrolet 1½-ton-truck hypoid axle, in the laboratory, on the rear-axle dynamometer shown in Fig. 1 Torque equivalent to full engine torque in low gear is applied by the large direct-current dynamometer connected to the rear-axle propeller shaft. The output is absorbed by the two alternating-current dynamometers attached direct to the wheel shafts. These a.c. dynamometers may be controlled at different speeds so as to provide any desired degree of differential action; or may be synchronized, as in these lubricant tests, to eliminate differential action and allow equal power absorption through both wheel shafts. The test conditions on the truck-axle dynamometer tests are outlined in Table 3.

A "passenger-car-duty hypoid lubricant," for use in General Motors passenger-car hypoid and highly stressed spiral-bevel rear axles, is required to lubricate satisfactorily a current model Chevrolet passenger-car hypoid axle without scoring or scuffing when tested under the procedure given in Table 2.

Complete correlation between the truck-axle dynamometer test and performance in service is lacking. However, the best available data appear to indicate that a lubricant which will operate for a minimum of 500,000 cycles under the conditions (outlined in Table 3) without scoring or scuffing of the pinion or ring-gear tooth surfaces or corrosion of the bearings or machined surfaces, will function satisfactorily in the Chevrolet 1½-ton truck under field service conditions.

Axle tests, on the lubricants given in Table 1, made in both passenger-car and truck axles under the conditions outlined in Tables 2 and 3, are reported in Table 4.

Tests were made also on the Almen,[10] four-ball,[4] S.A.E.[6] extreme-pressure-lubricant testing machines for load-carrying characteristics. These machines,

TABLE 2—PASSENGER-CAR HYPOID-AXLE TEST

Section 1:
- (*a*) Thoroughly clean axle housing and axle shafts, and install new third member.
- (*b*) Fill housing to the proper level with the lubricant to be tested.
- (*c*) Drive 3.8 miles at 60 m.p.h.
- (*d*) Drive 3.8 miles at 70 m.p.h.
- (*e*) Check axle for noise on a level concrete pavement, on the drive and coast, at 10 to 40 m.p.h. and 40 to 10 m.p.h. in high gear.
- (*f*) Drive 38 miles at 75 m.p.h.
- (*g*) Check noise as in Item *e*.
- (*h*) Drain lubricant into a clean container. Remove axle-housing cover and inspect the gears.

Section 2:
- (*i*) If the gears have not scored under the high-speed driving conditions outlined in Section 1, replace the axle-housing cover and refill with the lubricant, which was drained in accord with Item *h*.
- (*j*) Drive car in high gear to 70 m.p.h. Disengage clutch and turn off ignition. Permit car to coast to 65 m.p.h., and immediately engage clutch as rapidly as possible with transmission in high gear and with ignition turned off. With clutch still engaged and ignition off, permit car to decelerate to 40 m.p.h.
- (*k*) Repeat Item *j* six additional times.
- (*l*) Check noise, as in Item *e*.
- (*m*) Repeat Item *j* eight additional times, making a total of 15 decelerations in high gear.
- (*n*) Check noise as in Item *e*.
- (*o*) Drive car in second gear to 50 m.p.h. Disengage clutch and turn off ignition. Permit car to coast to 45 m.p.h., and immediately engage clutch as rapidly as possible, with transmission in second gear and with ignition turned off. With clutch still engaged and ignition off, permit car to decelerate to 20 m. p.h.
- (*p*) Repeat Item *o* four additional times.
- (*q*) Check noise, as in Item *e*.
- (*r*) Repeat Item *l* five additional times, making a total of 10 decelerations in second gear.
- (*s*) Check noise as in Item *e*.
- (*t*) Remove third member and inspect gears.
- (*u*) If the gears show no indication of scoring or scuffing on inspection [Item *t*], a second third member is installed and the axle refilled with fresh lubricant, and the entire test is repeated.

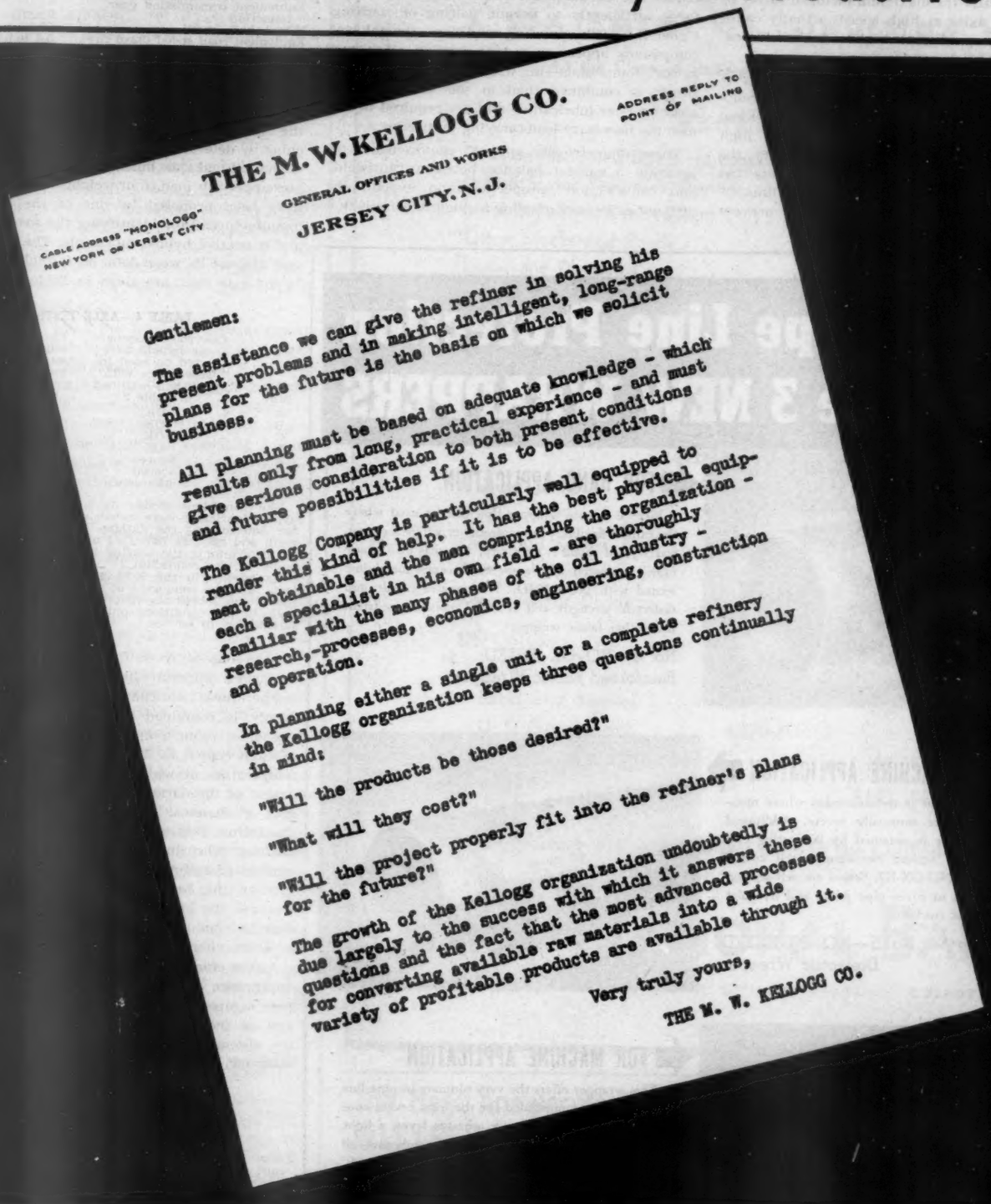
Examination of the gears may be made at any time during the test procedure, if the axle becomes objectionably noisy, or if scoring or scuffing is suspected.

when operated under their respective standard testing conditions, separate the hypoid lubricants from the mild EP lubricants and straight mineral gear oils, but do not differentiate clearly between passenger-car and truck-duty hypoid lubricants. When more complete data are available on the performance of a larger number of hypoid lubricants in heavy-duty truck service, modified operating conditions may be developed for one or more of these laboratory testing machines—which, in conjunction with the chemical composition of the lubricant, will classify more accurately hypoid lubricants for use in the several makes and models of hypoid axles.

### Passenger-Car and Truck Hypoid-Gear Lubrication Requirements

Engineering tests,[10,11] and experience in service over a period of years, clearly indicate that active sulfur is required to prevent scoring or scuffing—

# A Letter to Refinery Executives



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under the most severe driving conditions at high speed—in passenger-car hypoid-gear axles. These conclusions are confirmed by the data reported in Table 4.

Dynamometer tests and a limited experience on the road indicate that the more-active sulfur compounds, that offer the maximum factor of safety in passenger-car axles at high speed, actually cause scoring, at low speed under high-torque conditions, in heavy-duty-truck service.

A complete understanding of the function of each of the several load-carrying addition agents under all conditions of speed and load is lacking. However, it is known definitely that, at high speed, passenger-car hypoid gears require the type of powerful extreme-pressure lubricants that function through the formation of solid films,[5 9 10] which act as "antiwelding" fluxes to prevent metal-to-metal contact between the sliding or rubbing surfaces. The sulfide films, which give adequate protection at high speed in passenger-car service, increase friction;[5 10] and under the pressure-velocity (PV) conditions existing in truck service, at low speed and high torque, probably reduce the hardness or temper of the tooth surfaces sufficiently to permit scoring or scuffing. Under the truck operating conditions, the chlorine compounds appear to reduce friction. However, sulfur compounds—in which the sulfur more firmly is combined than in the very powerful passenger-car lubricants—still are required to furnish the necessary load-carrying properties.

These diametrically opposed requirements necessitate a careful balance between "antiweld" and "antifriction" properties, and explain the difficulties in compounding a single lubricant that will meet the most extreme conditions in both passenger-car and truck service.

**TABLE 3—TRUCK HYPOID-AXLE DYNAMOMETER TEST**

| | |
|---|---|
| Axle | Chevrolet 1½-ton |
| Axle ratio | 6/37 |
| Input torque | 1,157 lb. ft. |
| Propeller-shaft speed | 324 r.p.m. |
| Equivalent transmission gear reduction | 7.227:1 |
| Wheel-shaft speed | 52.5 r.p.m. |
| Equivalent road speed (32x6 tire) | 5.3 m.p.h. |
| Equivalent engine speed | 2,342 r.p.m. |

## Copper-Strip Test

The copper-strip test and a wear test made on the Almen extreme-pressure lubricant-testing machine by determining the combined loss in weight of the pin and split bushings on operating 20 minutes under 8-lb. load (four weights on loading beam) have been proposed by one of the automotive manufacturers[7] for identifying the so-called active and nonactive hypoid lubricants. The copper-strip and Almen-8-lb. wear data, on the lubricants used in the axle tests, are given in Table 5.

**TABLE 4—AXLE TESTS**

| Lubricant | Chevrolet passenger-car hypoid axle tested on road in accordance with conditions outlined in Table 2 | Chevrolet 1½-ton-truck hypoid axle tested on dynamometer in accordance with conditions outlined in Table 3 |
|---|---|---|
| A | OK | Scored |
| B | OK | OK |
| C | OK | OK |
| D | OK | OK |
| E | Scored | Scored, corroded |
| F | Scored | Scored |
| G | Slight score | No test |

The conditions (Table 3), under which the truck hypoid lubricants were tested, were originally designed for determining the fatigue life of the pinion-gear teeth and may, as indicated in the text, be too severe for determining the scoring tendencies of a lubricant under service conditions.

Experience in the field may indicate that scoring tests must be conducted at a lower torque input, and that some lubricants that permit scoring under the high torque conditions outlined in Table 3 may be satisfactory in service.

Lead-soap active-sulfur hypoid lubricants and sulfurized mineral oils blacken copper at room temperature. Lubricants in which the sulfur more firmly is combined chemically do not blacken copper at room temperature, but may darken or blacken copper at 210° or 300° F. The minimum temperature at which darkening occurs, and the extent of the darkening, indicate roughly the degree of chemical combination or the activity of the sulfur. This test, however, may be quite misleading. The lubricant may contain a small amount of sulfur in a very active form, and may blacken the copper strip at room temperature, whereas the bulk of the sulfur in the lubricant may be combined too firmly to impart extreme-pressure characteristics.

Active chlorine does not appreciably affect the appearance of the copper strip. Sulfur and chlorine compounds, depending upon their activity, and on the amount present in the lubricant, in the absence of lead soap or some other suitable inhibitor, may corrode steel—particularly in the presence of water. Consequently, a positive copper-strip test indicates only the availability of a portion of the sulfur addition, and does not predict the behavior of the lubricant in service with respect to corrosion.[9 10]

**TABLE 5**

| Lubricant | Copper-strip test: 5 min. at 75° F. | 1 hour at 210° F. | 1 hour at 300° F. | Almen 8-lb. wear test: total loss, pins and bushings, (grams) |
|---|---|---|---|---|
| A | Positive | Positive | Positive | 0.031 |
| B | Negative | Negative | Tarnished | 0.001 |
| C | Negative | Negative | Positive | 0.002 |
| D | Negative | Negative | Positive | 0.004 |
| E | Negative | Negative | Negative | 0.003 |
| F | Negative | Negative | Tarnished | 0.002 |
| G | Negative | Tarnished | Positive | 0.002 |

The Almen 8-lb. wear-test data reported in Table 5, as well as a large number of tests made on mixtures of so-called active and inactive lubricants, indicate that this test may be considered only as a refinement of the copper-strip test—a


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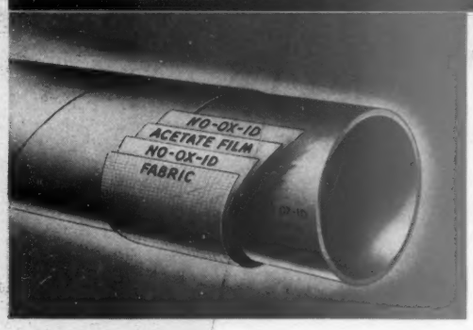


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Reinforced Fabric Wrapper

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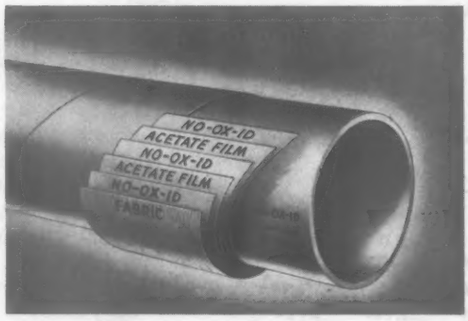


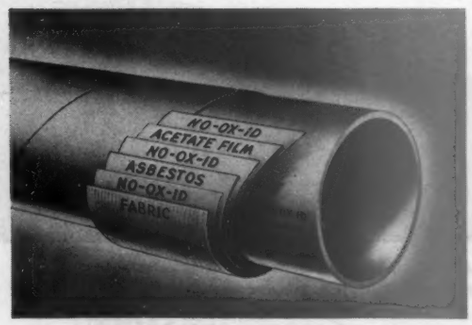


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quantitative copper-strip test—for more accurately evaluating the activity of the sulfur addition. A high Almen wear test, in the absence of foreign abrasive matter, generally indicates active sulfur. A high Almen wear test, therefore, may indicate that the lubricant is unsuited for truck service. However, a low Almen wear test does not necessarily indicate suitability for truck service—the lubricant may be low in load-carrying properties. Conversely, a high Almen wear test may indicate suitability for passenger-car service, but a low Almen wear test would not indicate necessarily that a lubricant is either superior or inferior for passenger-car hypoid gears.

### General Motors Recommendations

Car-owner's instruction books and shop manuals specify the use of "passenger-car-duty hypoid lubricants" in all 1940 General Motors passenger-car rear axles and in the Chevrolet ½ and ¾-ton truck hypoid axles. "Truck-duty hypoid lubricants" are specified for use in the Chevrolet 1½-ton truck hypoid axle.

In order to meet the lubrication requirements of General Motors hypoid-gear rear axles "passenger-car hypoid lubricants" must comply with the requirements outlined in Pars. 1 and 2 of the "General Motors Specifications for Hypoid-Gear Lubricants" (July 1939), and "truck-duty hypoid lubricants" must be capable of operating a minimum of 500,000 cycles without scoring or scuffing of the gear-tooth surface under the conditions outlined in Table 3.

### Future Developments

In converting from the spiral-bevel gear to the hypoid gear, most manufacturers took advantage of the higher tooth strength of the hypoid design, and reduced the diameter of the new hypoid ring gear; but as in the case of all new designs, full advantage of this increase in tooth strength was not realized, and the hypoid-gear set was not reduced to the minimum size or weight. An increase in speed and a further reduction in ring-gear size have been announced for 1940 production by at least one automotive manufacturer.

This trend toward the more efficient utilization of gear materials undoubtedly will be seen in many future axle designs. It, therefore, would appear that the lubrication requirements for hypoid-gear axles may become more critical, and that new types of extreme-pressure addition agents may have to be developed to meet future requirements.

The immediate problem is one of recognizing the difference in passenger-car and truck requirements, and of marketing to the car owner and car dealer the correct lubricant for each type of service.

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1st NATIONAL

• STATEMENT OF CONDITION •

At the Close of Business, October 2, 1939

ASSETS

| | |
|---|---|
| Cash on Hand and Due from Banks | $ 73,014,020.46 |
| United States Securities Owned | 21,828,100.00 |
| Stock in Federal Reserve Bank | 324,000.00 |
| Other Stocks and Bonds | 2,858,366.76 |
| Loans and Discounts | 45,529,713.75 |
| Furniture and Fixtures | 298,865.41 |
| Banking House | 2,345,000.00 |
| Other Real Estate | 1,138,730.64 |
| | $147,336,797.02 |

LIABILITIES

| | |
|---|---|
| Capital Stock | $ 8,000,000.00 |
| Surplus Fund | 2,800,000.00 |
| Undivided Profits, Net | 3,682,978.67 |
| Reserved for Taxes, Etc. | 335,478.05 |
| Reserved for Dividend | 160,000.00 |
| DEPOSITS | |
| Individual | $81,925,527.46 |
| Banks and Bankers | 45,662,462.14 |
| U. S. Government | 4,770,350.70 |
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# The Road Traveled... and the Road Ahead

By BAIRD H. MARKHAM
American Petroleum Industries Committee, New York

WE hear a great deal today of the "World of Tomorrow." We all have a stake in the World of Tomorrow—and each one of us here this morning can play a definite part in making it a little better place in which to live. Our efforts in the future will be molded by what we have learned in the past—by the lessons we have drawn from our experience, and from the experience of others. Before we attempt to survey the road ahead, then, I should like to take you back along the road we have traveled together.

### How We Begin

Perhaps a word recently added to the language—"Hellzapoppin"—adequately describes the situation in 1933 when we began our efforts.

We had little more than a plan and a program. We were a loosely knit group, functioning on an emergency basis in an attempt to work with a largely uninformed industry which was trying to save itself from becoming entangled hopelessly in a network of hastily conceived tax legislation that frequently was ill-advised and almost always hastily enacted. Panaceas were the order of the day. To cope with the hundreds of measures introduced during the 93 regular and special legislative sessions which were held that year on the one hand, while perfecting an organization on the other, was, to say the least, a strenuous assignment. The task of analyzing the problems presented in more than 6,000 bills which had been introduced affecting the petroleum industry and its customers, and the work of gathering the necessary factual material upon which to base an opinion, in order to decide upon a course of action, were likewise exceedingly difficult.

### How We Developed

Today we can proceed in an orderly fashion. We are fortified with the results of 7 years of intensive research which has produced adequate educational and statistical material; an abundance of reference data has been compiled, and is now available; and a general educational program has been formulated and has been, and is being, put into effect. We have the benefit of our individual and collective experiences, and the lessons which both our failures and successes have taught us. The objectives that lie before us clearly are defined. Today, 37 states and the District of Columbia are organized—down to the last county. We have effectively functioning state committees in 46 states and the District; 2,403 of the 3,066 counties in the nation possess active local organizations.

All of these facts are indicative of the magnitude and breadth of our program. They do not signify that the task is complete. They do not mean that the emphasis on any phase of our activity has diminished. Ours is a continuing problem, and our obpectives will be accomplished in direct ratio to the efficiency of our organization as a whole.

That much progress has been made, no one can deny. I am more than proud and appreciative of the way in which our state and county committees, their officers and staffs, have cooperated in carrying out their programs of activity.

Some tasks accomplished suggest we have progressed; but the fact remains that our most effective work lies ahead. Any self-confidence we have arises only from the realization that what we have accomplished will be useful in planning for the future.

I like to compare our growth, and our relation to the future, with the development of the modern technique of fighting fires.

### The Bucket Brigade

Many of us remember the old bucket brigade. When the fire gong loudly called every person in town to attention, it was a motley crew that went into action. Dashing to the fire afoot or on horse, sometimes stopping off to pick up the best girl for the big show, the crew arrived on the scene and began its sincere, but oftentimes ineffective, efforts to put out the fire. Often, it is said, rival companies of volunteers fought each other to see which would have the privilege of dousing the flames, with a pleasant disregard of the fact that valuable property meanwhile was being reduced to ashes. But, in general, the philosophy of the volunteer company was—to put out the fire, before it did too much damage.

Today, the emphasis has shifted to one of fire prevention. The idea is to obviate, as far as humanly possible, the necessity of fighting fires. The object is to see that they don't get started. Then, if the emergency does arise, trained crews know just what to do and how to do it.

In our first days of operation, we, too, functioned much like a bucket brigade. When the legislative alarm sounded, we sometimes stumbled over our own feet in preparing our defenses.

Now, after 7 years of experience we know where many of the fire hazards are: We now can proceed to eliminate these. No longer is it necessary to wait until the fire starts. No longer are we concerned principally with extinguishing the fire—before it does too much damage. Now we are more concerned with preventive measures.

And that is what I mean when I say that our most effective work lies in the future.

In other words, we believe that we have reached an important turning point in our development. We now have a functioning organization, and firmly established policies to guide it. We now are ready, willing, and able to provide the facts that will lead to a sane and sound solution of the tax problems which confront our industry and its customers. We are prepared to render assistance to allied groups which have a mutual interest in our objectives. We are equipped and anxious to make our contribution to the furtherance of economical government.

### Progress Reviewed

At this time I should like to review briefly the experience we have had in terms of the major problems which have demanded the attention of the committee.

A moment ago, I emphasized the fact that our most important object is to reduce the number of problems which require emergency action. I want to emphasize it again. The nature of the problems which face us is such that they never are eliminated. Potentially, each of the problems hereafter mentioned now looms as large a danger spot as it did in 1933, and I surely do not wish to leave the impression that they have ceased to demand the vigilance they always have demanded.

**Gasoline Tax.**

It would be reasonable to presume that the revenues from the gasoline tax have been in as great demand during the years from the depths of the depression in 1932 to the present date as they were in the period from 1927 to 1932. Yet in the 7 years prior to 1933 no less than 75 state gasoline-tax increases were enacted; 67 of these were permanent, 8 were temporary. During the 7 years from 1933 through 1939 only 12 states have increased the gasoline tax. Of these, only five are permanent, while seven are "temporary emergency" measures. The change in this trend during recent years undoubtedly can be attributed to the growing public consciousness of the burden of these levies and to the mounting opposition of motor-vehicle owners. But the fact that the gasoline tax has not diminished as the "apple" of the money-hungry legislator's eye is evidenced by the fact that during the past 7 years 331 measures have been introduced in state legislatures to increase or reenact gasoline taxes. In fact, bills to increase tax rates were introduced in 16 states this year; but only one increase—and that of questionable constitutionality—thus far has been enacted.

**Diversion.**

The expenditure of revenues from gasoline

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***A.P.I.*** **— Presented before annual meeting, Chicago, Ill., November 13-17, 1939**

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taxes and motor-vehicle registration fees on projects unrelated to highways is a source of grave concern to the petroleum industry.

It is true that the practice largely is of depression origin. The pressure for revenue with which to bail out sinking state budgets was applied with greatest force after the 1929 crash. But the problem by no means is a recent one. As a matter of fact, the total funds diverted to nonhighway use increased 537 per cent during the period from 1928 through 1932. From 1933 through 1938 the increase was 76 per cent.

In 1936, 16 cents out of each motorist's tax dollar was diverted. In 1938, 13½ cents of this dollar was misappropriated.

Heartening indeed is the tangible progress toward the arrest of diversion which has been made. By 1933, three states—Missouri, Minnesota, and Kansas—prohibited diversion by provisions in the constitutions. Since that time Colorado, California, Michigan, and New Hampshire also effectively have forbidden the practice by constitutional amendments. Furthermore, the legislatures of the states of Iowa, Wisconsin, Nevada, Idaho, and South Dakota have taken steps to present similar amendments to their electorate. No less than 14 other states have given legislative attention to presenting such amendments to their voters.

The method of restricting the use of revenues from special motorists' taxes to highway purposes only by constitutional amendment is a good illustration of the preventive measures which can be taken.

The sharing of motorists' tax revenues with localities is akin to, if not a species of, diversion. You all are familiar with the problems involved, but I cannot emphasize too strongly the need for greater diligence with respect to this matter. If we read the signs aright, there will be increasing demands for sharing of state-highway revenues. During the legislative sessions of 1939, 122 such bills were introduced. Indicative is the fact that such laws were enacted in 9 states.

**Tax Evasion.**

As long as it is profitable to evade a tax—and it always is profitable when the tax is levied at disproportionate rates—tax evasion and avoidance will result to confound the administrator.

This is a good example of what is meant by a continuing problem. We have made great forward strides in the drive to eliminate the evader. The cooperation of the industry with the tax administrator greatly has reduced the volume of evasion. But the problem of evasion will remain as long as certain members of society seem unable to resist its temptation, or until the taxes have been reduced to the extent that it no longer pays dividends to avoid the payment of the tax. Continued diligence is the only answer.

**Exemptions and Refunds.**

The principle that gasoline consumed in nonhighway uses should not be taxed is an equitable one. Unfortunately, the serious abuse of the privilege has given rise to considerable doubt in the minds of administrators as to whether a system of refunds ever can be made practicable. Too often the refund has been a direct avenue of tax evasion. The scope of refunds gradually is being limited to the point at which evasion of the tax will be reduced to a minimum. The growing conviction that effective enforcement is only good business, when tax revenues are at stake, plus the enlargement of tax-administrative staffs, is resulting in a tightening-up of the entire refund situation.

**Deferred Registration.**

One of the most constructive of the objectives of the committee has been to seek the establishment of a date for motor-vehicle registration other than January 1.

Inasmuch as the plan evidently is of benefit to everyone—especially to the state, which enjoys increased gasoline-tax collections as a result of it—it is not extraordinary that the proposal has been well received. The acceptance of the idea has been widespread and rapid.

n 1933 only 6 states allowed deferred registration of motor vehicles, while 42 states and the District of Columbia required registration in January. Now 43 states and the District of Columbia have postponed the registration date beyond January. In 1939 the legislatures of six states enacted deferred-registration provisions. Governor Lehman vetoed the will of the legislature in New York State, for reasons not entirely clear; but the other five measures have become law.

**Oil-Fuel Taxes.**

We have encountered intermittent threats to impose discriminatory taxes on fuel oil. As yet the proponents of fuel-oil taxation have made no headway. The continued depression which haunts the coal industry, however, suggests that the possibility of further attempts to tax the product is by no means remote.

**Alcohol-Gasoline.**

Proposals made for the blending of agricultural alcohol with gasoline as a motor fuel were more insistent and prevalent in 1939 than in any year since 1933. Bills to force or encourage the use of the blends were introduced in four state legislatures in 1939; and such a bill, in modified form, found its way to the statute books of Nebraska. Strenuous efforts were made to exempt such blended fuels from the federal gasoline tax through an amendment introduced in Congress by Senator Gurney of South Dakota. A senate committee held protracted hearings on the bill.

It is reasonably safe to presume that this issue will be continued in the coming session of Con-


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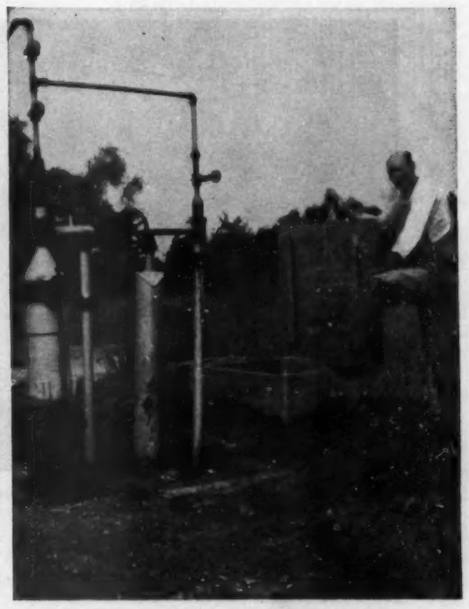

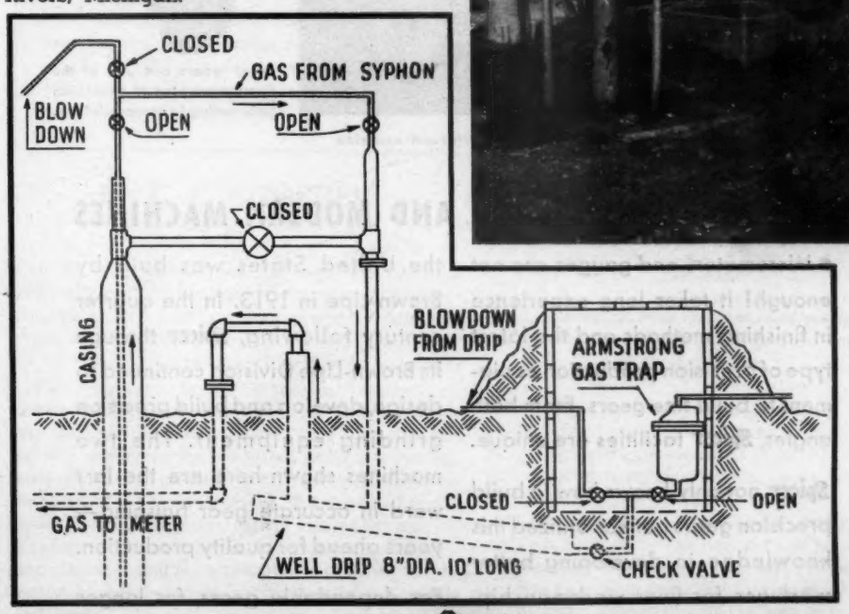


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gress, and that encouragement has been lent its proponents in the various state legislatures.

**Chain-Store Taxes.**

In recent years the petroleum industry has become the innocent victim of a movement to equalize opportunity for small, independent merchants who have been faced with competition from large organizations with facilities which enable them to effect substantial marketing economies. Although there has been no need for equalizing competition in the petroluem industry, in certain states the outlets of the industry have been included under the provisions of chain-store tax laws.

In 1933, 13 states levied taxes on chain stores, and 6 of these applied to petroluem outlets. As of today, 21 states impose chain-store taxes—although the number which does not exempt service stations has not increased; 15 of the 21 chain-store laws now exempt the outlets of the industry.

Despite the fact that chain-store taxes were proposed in the legislatures of 16 states during 1939, none has been enacted. A measure was introduced in Congress which would subject the multiple outlet to severe taxation, but this measure still is pending. Indications definitely are that the states now are veering away from this punitive legislation.

**Privilege Taxes.**

State and local privilege taxes are a field in which a lot of hard work is beginning to bring some order out of chaos. In the coming off-legislative year, many state organizations will be able to make additional progress in this field; and I should emphasize its importance. Although the savings to the retail marketer from the elimination of these pesky measures may appear small in dollars and cents, these local ordinances are exceedingly troublesome, and usually unfair to the small operator who is attempting to make a living through the sale of petroleum products.

**Highway Legislation.**

Legislation dealing with highways and motor vehicles evidently is increasing, and apparently will continue to increase. However, it is gratifying to note that for the past two years the character of this legislation has been more favorable to commercial highway users, and to highway transportation generally, than was the case prior to that time. This, I believe, may be attributed to a better understanding on the part of the public of the value of highway transportation; and this, of course, is only brought about through intelligent educational efforts by the automotive, truck, and petrolume industries. However, we well may expect a continuation of the movements to limit the size and load of trucks, further legislation relative to dimensional limitation, bills restricting week-end operation, the further regulation of private carriers, and other measures of this kind.

On the other hand, the movement toward reciprocity in interstate-highway transportation is making favorable headway; while such uneconomic measures as ports-of-entry laws, mileage taxes, and the like are apparently on the way out. Nevertheless, transportation competitive with highway transportation may be expected to continue its efforts to drive the truck off the roads. However, it is believed that now we have reached the point where the public is sufficiently aware of the benefits of highway transportation, and the point at which highway transportation itself is becoming sufficiently well organized that we may expect a militant campaign by highway-user groups against the continuation of unreasonable regulatory proposals.

**Highway Safety.**

Highway safety is a question in which we have both a humanitarian and an economic interest. I believe that we are at a point where we confidently can expect further reduction in highway accidents, and I think that this will come about partly as a result of findings flowing from the state-highway surveys now being completed; for undoubtedly the removal of dangerous curves, short sight distances, and the like will continue to be made with increasing rapidity. The effectiveness of safety campaigns has been, and will continue to be, of great importance in reducing the hazards of driving. Manufacturers, too, continually are building safer automobiles.

**Highway Finance.**

Generally speaking, highway finance is a problem which has not received the attention from our organization which its importance justifies. Too often it has been thought that the bond issue should remain exclusively in the province of the financial expert. Sad experience has shown, however, that bonded indebtedness—demanding steady revenue for its interest and retirement—may be the controlling factor in maintaining taxation at a disproportionately high level.

Too many states, and too many counties, have borrowed beyond their credit for road building. Too often these highways have been built without regard to whether the roads are justified by traffic demands. Many roads financed by long-term issues had been strictly "Model T" roads—and soon became utterly inadequate for modern requirements. These roads, worn out and inadequate, sometimes were replaced with new highways long before the old ones had been paid for.

As a result, several states are faced with large bond maturities during the next two or three years, and we may expect highway-refinance programs to be the order of the day. Because these programs have such an important effect for a period of many years, careful analysis of all such refundings is a "must" for every highway-user group. . . .


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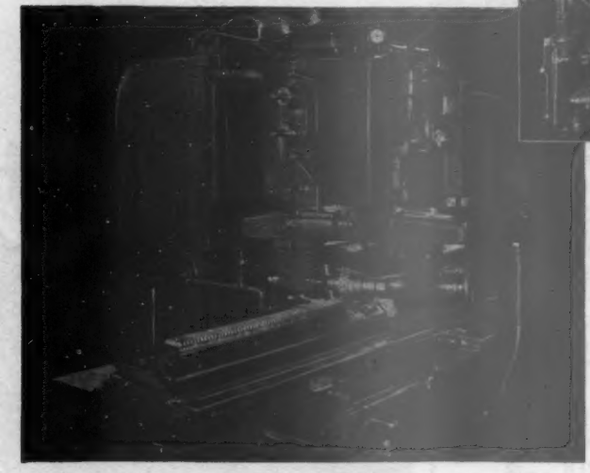

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# Cooperative Problems Involved in

# Cathodic Protection


## ABSTRACT

**The paper is a summation of the early history of cathodic protection in its application to the pipe-line industry. The organization of the Mid-Continent Cathodic Protection Association—together with its aims, purposes, accomplishments, and limitations—is discussed in some detail. Data presented show the details of the application of this form of protection to the petroleum industry, and indicate clearly its rapid growth within the past few years.**

**Many of the serious problems now confronting the cathodic engineer are discussed in detail. The eminent hazards of liability and involvement are pointed out, with a plea that they be given consideration.**

**The rapid increase in recognition, and the general use of this form of protection, clearly indicate that the mutual problems arising soon will reach the point where they can no longer be handled amicably through individual agreement. Because of the tremendous liabilities which may be created through lack of understanding, good practice, or standardization, the directed control of this work soon may become a serious concern of the entire industry.**

**It is suggested that, in its capacity as clearing house on problems of mutual concern to the petroleum industry, the American Petroleum Institute peculiarly is suited to act as the medium through which this rapidly growing technological work may be organized and studied.**



**By L. F. SCHERER**

Texas Pipe Line Co., Houston, Tex.


STATED simply, cathodic protection is a method of preventing electrolytic corrosion by raising the potential of the soil above that of the pipe line to be protected by an amount sufficient to inhibit discharge of current to the soil; in other words, the pipe line is made cathodic. The means by which this may be accomplished mechanically is detailed in various articles . . . and they will be discussed rather generally herein.

The use of cathodic protection in mitigating electrolytic corrosion is not new, patents having been issued on certain applications as early as 1908.* Much of the early electrolysis work was based upon stray-current losses, usually from electric street railways. The cathodic condition, however, was recognized during the period 1911 to 1916, and at least two successful cathodic units were installed during that period.†

Work conducted by the national Bureau of Standards prior to 1918‡ indicated the feasibility of using motor-generator sets for cathodic units. In Technologic Paper 52, the need of regulation regarding electrolytic mitigation was stressed, and it was suggested that joint action between interested parties be sponsored by the American Committee on Electrolysis.§

Records indicate that the first successful installation made on a gas or oil line purely for the purpose of mitigating electrolytic corrosion was installed on a gas pipe line in Texas in 1932 by Starr Thayer, who had been independently active in the pipe-protection and corrosion field for some time previous. The results of that installation pointed the way by showing that such installations were both practical and economical. Experimental work proceeded slowly until 1934. Since then advancement has been rapid.

### Time-Leak Relationships

A study of Fig. 1 shows clearly the efficacy of cathodic protection applied to a pipe line. Curve *X* is a typical record of cumulative leaks as recorded for an 8-in. pipe line without cathodic protection. Curve *Y* is the record of a similar line upon which cathodic protection was applied. The trend before application of protection was similar to that of the unprotected line.

The mechanical application of cathodic protection consists of applying a source of potential between the pipe line and a suitable ground bed buried in the soil at a point some distance from the pipe line. The negative lead is connected to the pipe line, and the positive lead is connected to the ground bed. The source of potential may be a battery, motor-generator set, rectifier, windmill, or engine-powered generator.

### Types of Equipment

Due to the realtively recent application of cathodic protection to the industry, and because much of the work is conducted by individuals and is of an experimental nature, the diversity in types of equipment is tremendous—being limited only by the ingenuity of the engineers and the availability of mechanical combinations. The illustrations shown herein are of generally accepted types of units, and are by no means indicative of all the equipment available (Figs. 2 to 6, inclusive).

The improvement in mechanical design and construction of cathodic units has been tremendous during the past 5 years. This was not due to any concerted or organized action, however; but, rather, the result of intensive application on the part of a few individuals. There is still much room for improvement in the reliability and efficiency of these units, but to accomplish this expeditiously and economically requires standardization of requirements and unified action by the industry.

The Mid-Continent Cathodic Protection Association recently conducted a questionnaire survey with the object of determining the extent to which cathodic protection is applied to pipe lines as well as certain factors pertaining thereto. Sixty-seven companies were contacted, and replies were received from 42 of them. The results of this investigation are shown in Tables 1 to 8 inclusive. Groupings were made on the basis of the number of units in use by the individual companies.

Although it is realized that all users were not contacted, it is felt that the above figures include the majority of the units in operation, and are sufficiently inclusive to show representative results. It is evident that two or three companies have applied cathodic protection extensively. These organizations report approximately 50 per cent of the units installed, and show approximately the same percentage of total miles of pipe protected.

At least half of the companies reporting are within the lowest two groups. This would seem to indicate that they are just beginning to apply cathodic protection, or are in the experimental stage. Much time and expense could be saved these companies through standardization, education, and cooperation.

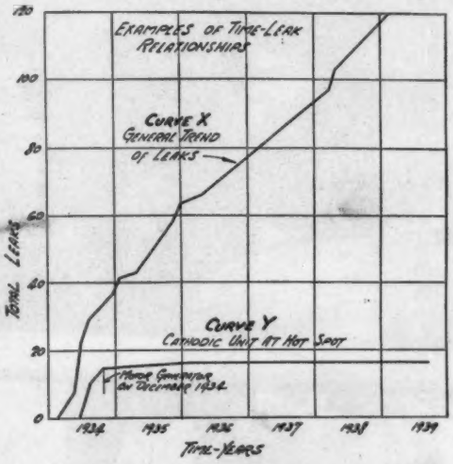



*Fig. 1—Curves showing time-leak relationship between line having no cathodic protection and cathodically-protected line*

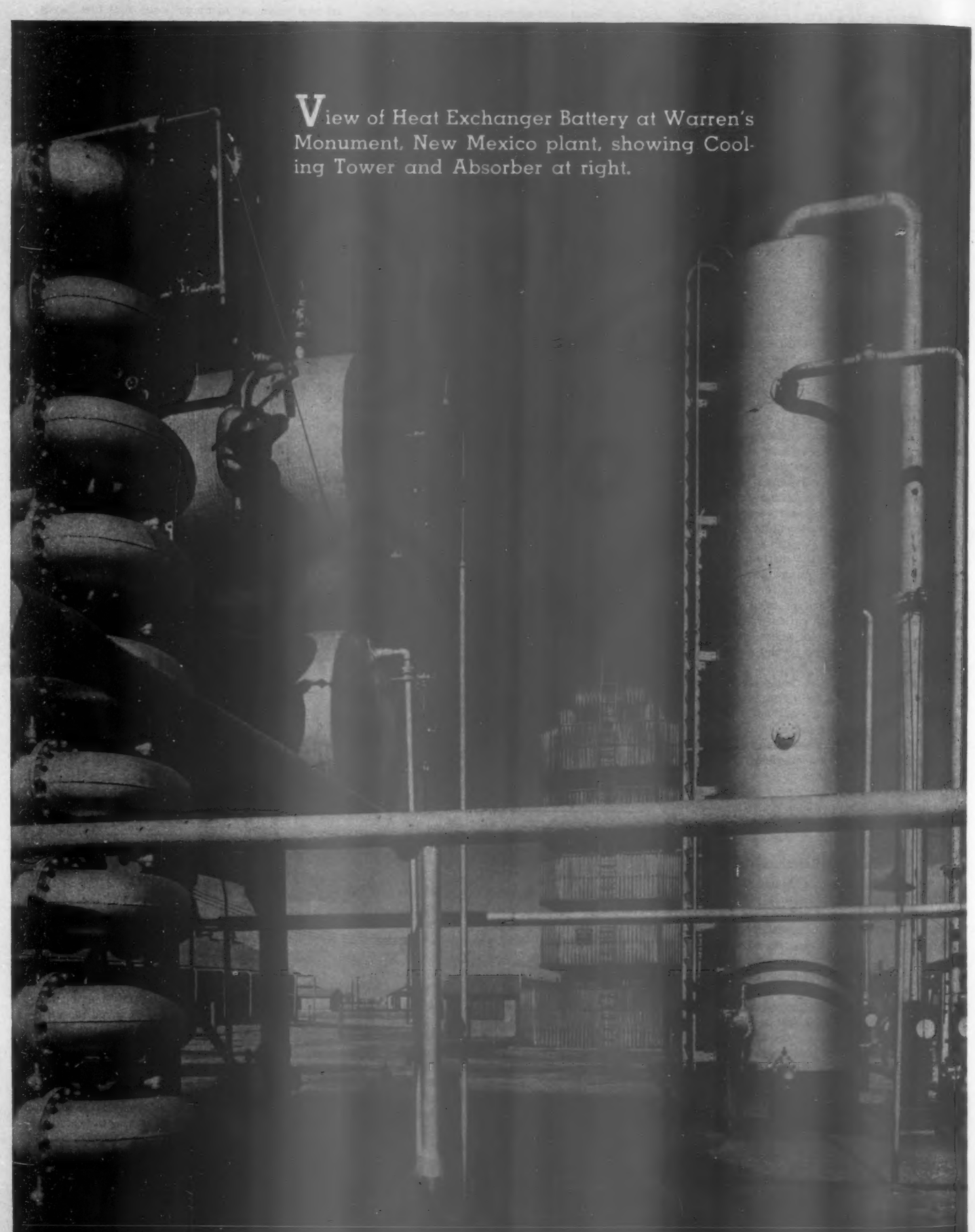
The tremendous interest in the application of cathodic protection was brought out by the large number of requests (by present nonusers) for general as well as specific information. In addition to the installations tabulated, it was indicated that approximately 75 additional installations are contemplated before the end of the current year.

### Committee Formation

By 1934 the increased interest in this type of corrosion mitigation had begun to show the need of joint action in cases of involvement. The matter was brought to a head by the difficulties being experienced by pipe-line companies in the area east and southeast of Chicago. This area is highly industralized and congested. Pipe lines, underground telephone and telegraph cables, utility services,

*Ger. Imp. Pat. 211612, issued to Herman Geppert, July 9, 1909, covers from Mar. 27, 1908.
†Prof. Albert F. Ganz installed M.G. set on gas main, New York; Sexaur on Western Union cables at Galveston, 1912.
‡Natl. Bureau of Standards Technologic Paper 52.
§Discontinued during period of World War.


**A.P.I. — Presented before annual meeting, Chicago, Ill., November 13-17, 1939**



View of Heat Exchanger Battery at Warren's Monument, New Mexico plant, showing Cooling Tower and Absorber at right.

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street-car lines, and electrified-railway crossings—with interchanging current and all owned by different interests—presented a difficult problem for solution.

**TABLE 1—TOTAL NUMBER OF UNITS**

| Group (number of units) | Number of companies | Total units in group |
|---|---|---|
| 1- 5 | 7 | 11 |
| 6-10 | 7 | 55 |
| 11-15 | 2 | 22 |
| 16-20 | 4 | 72 |
| 21-25 | 1 | 23 |
| 26-30 | 2 | 55 |
| More than 30 | 3 | 304 |
| Totals | 26 | 542 |

**TABLE 2—NUMBER OF MILES OF PIPE PROTECTED**

| Group (number of miles) | Number of companies | Miles in each group |
|---|---|---|
| 1- 25 | 13 | 172 |
| 26- 50 | 2 | 56 |
| 51- 75 | 4 | 225 |
| 76-100 | 2 | 163 |
| 101-125 | .. | .. |
| 126-150 | .. | .. |
| 151-175 | 1 | 170 |
| 176-200 | 1 | 195 |
| More than 200 | 3 | 1,025 |
| Totals | 26 | 2,006 |

**TABLE 3—RECTIFIERS**
Range 80 to 1,500 Watts

| Group (number of units) | Number of companies | Units in group |
|---|---|---|
| 1- 5 | 11 | 20 |
| 6-10 | .. | .. |
| 11-15 | 2 | 24 |
| 16-20 | 1 | 16 |
| 21-25 | .. | .. |
| 26-30 | 1 | 26 |
| More than 30 | 1 | 65 |
| Totals | 16 | 151 |

**TABLE 4—MOTOR GENERATORS**
Range, ¼ to 7.5 Kilowatts

| Group (number of units) | Number of companies | Units in group |
|---|---|---|
| 1- 5 | 6 | 17 |
| 6-10 | 2 | 16 |
| 11-15 | .. | .. |
| 16-20 | 2 | 35 |
| Totals | 10 | 68 |

**TABLE 5—WINDMILLS**
Range, 200 to 1,600 Watts

| Group (number of units) | Number of companies | Units in group |
|---|---|---|
| 1- 5 | 15 | 35 |
| 6-10 | 6 | 40 |
| 11-15 | .. | .. |
| 16-20 | 2 | 35 |
| 21-25 | 1 | 22 |
| More than 25 | 1 | 96 |
| Totals | 25 | 228 |

**TABLE 6—GAS OR GASOLINE ENGINES**
Range, 0.4 to 4 Kilowatts

| Group (number of units) | Number of companies | Units in group |
|---|---|---|
| 1- 5 | 4 | 7 |
| 6-10 | 1 | 6 |
| 11-15 | 1 | 15 |
| 16-20 | .. | .. |
| 21-25 | .. | .. |
| More than 25 | 1 | 67 |
| Totals | 7 | 95 |

**TABLE 7—NUMBER OF BONDS TO FOREIGN LINES**

| Group (number of bonds) | Number of companies | Number of bonds |
|---|---|---|
| 1-10 | 13 | 79 |
| 11 20 | 3 | 46 |
| 21-30 | .. | .. |
| More than 30 | 2 | 257 |
| Totals | 18 | 382 |

**TABLE 8—PROPORTION OF VARIOUS TYPE UNITS**

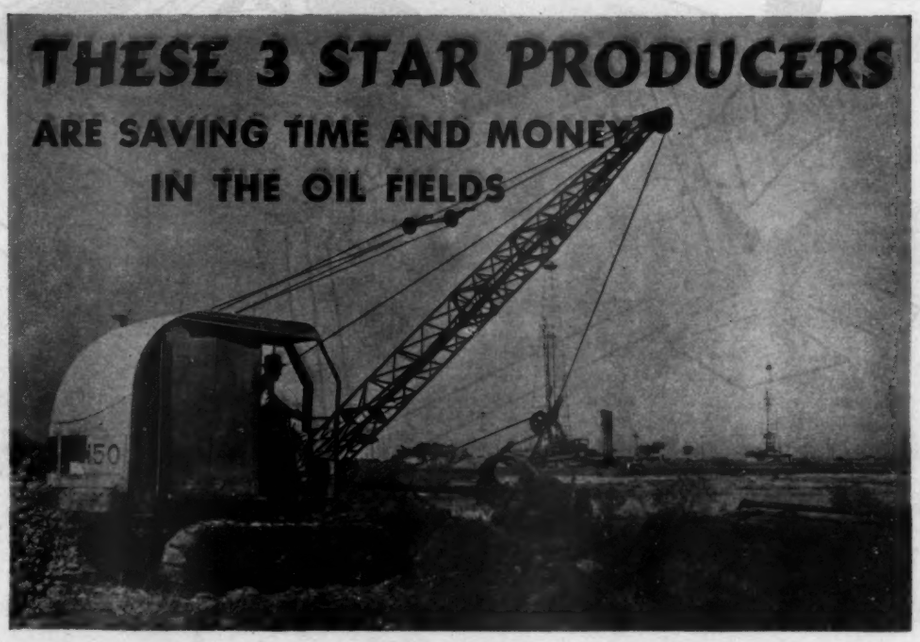
| | Number in use | Per cent |
|---|---|---|
| Rectifiers | 151 | 27.9 |
| Motor generators | 68 | 12.5 |
| Windmills | 228 | 42.1 |
| Engine-powered | 95 | 17.5 |
| Totals | 542 | 100.0 |

A committee composed of representatives of the involved interests was formed. This committee drafted a test procedure, and conducted a joint survey of all structures. This voluntary organization, through cooperation and discussion of their joint problems, was successful in definitely reducing electrolytic damage in this area. It clearly pointed the way to the need of a permanent organization to deal specifically with the problems involved in electrolytic-mitigation work. Such an organization would be at once a clearing house for essential information and advice in joint involvement, and would serve as a means of disseminating data pertinent to industry.

With this object in mind and realizing that the problems of initial responsibility rapidly were becoming involved, a group of interested pipe-line engineers met in April 1936 to discuss the feasibility of forming such an organization. Their subsequent discussions resulted in a called meeting of representatives of all interested pipe-line companies, and at this meeting the Mid-Continent Cathodic Protection Association was formed.

Membership in the organization is voluntary, and no assessments are made—expenses being carried on by the organizations of those members most active in mitigation work. Its aims are primarily to act as a clearing house in cases of joint involvement, to meet as a group to permit free discussion of the many problems arising, and to act as a means of disseminating information on electrolytic mitigation to all interested parties. In these aims it has been sufficiently successful to prove conclusively to the industry as a whole that a properly financed organization, with a recognized background and dealing specifically with the problems pertinent to electrolytic mitigation, is definitely necessary to the organized advancement of this phase of the pipe-line industry.

Under the present state of affairs it is frequently difficult to convince one party in a joint problem of his initial responsibility. No rules nor regulations have been laid down. Because it is possible that liability be created through the application of cathodic protection, it is highly desirable to keep the subject free from legal entanglements—particularly so because of the technical and specialized nature of the subject. The Mid-Continent Cathodic Protection Association, having a purely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voluntary membership, lacks authority or prestige to act in matters of arbitration or to establish rules of procedure other than such ethics as may be established by its individual members.

### Electrolytic Problems

In order that a better understanding may be had of some of the problems which now plague electrolysis engineers, it may be well to cite and discuss them here.

One of the major issues, as mentioned previously, is that of establishing initial responsibility

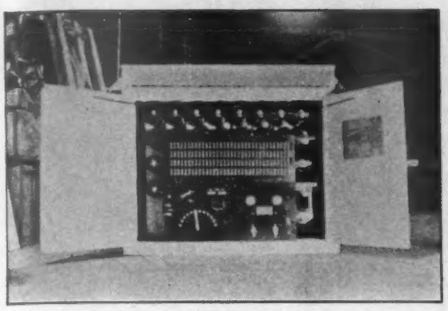

*Fig. 2—Alternating-current converter (rectifier)*

in the solution of a problem involving two or more pipe lines. This may occur in the case of parallel, or crossing lines and, most frequently, in bonding work. Ordinarily these problems may be adjusted readily by the field men when only a few lines are involved. When numerous lines and facilities are involved, arbitration is usually successful. Instances of an arbitrary attitude on the part of individuals so far have been gratifyingly infrequent. It is entirely conceivable, however, that some pipe line may become gravely liable and become involved legally in the future. It is this contingency against which we must guard by establishing precedents and rules of procedure.

**Form of notification.**

In this connection it must be pointed out that one of the cardinal requirements is the establishment of a required form of notification of intent

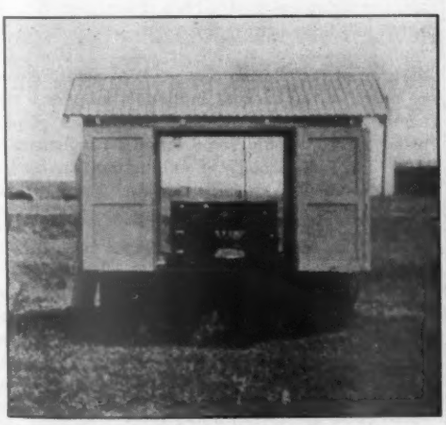

*Fig. 3—Motor-generator unit installation*

which the initiating carrier must follow in advising others who may be involved. The Mid-Continent Cathodic Protective Association has developed such a form, but lacks the prestige to obtain its general use. For use with this form, it has worked up an index showing the pipe lines in each county of the Mid-Continent area. . . .

**Adequate records.**

Properly to conduct an electrolytic-mitigation program, it is essential that each company maintain a complete set of records showing a maintained history of its lines, its cathodic units, ground beds, etc. At present there is no standardized method by which this information is kept. Records kept in some uniform manner greatly would facilitate the exchange of information between carriers, and no doubt would result in economies in the pursuit of each company's program. It has been suggested, for instance, that when "miles of pipe protected" are discussed, the pipe in question be reduced to terms of "equivalent 12-in. pipe." Many worthwhile suggestions in regard to the above are embodied in a paper* presented before the May meeting of the Mid-Continent Cathodic Protection Association.

**Clearing house.**

A body which would act as the medium through which could be passed information regarding new equipment and units would be most helpful. Such an organization would assist in establishing standards of uniformity and reliability which undoubtedly would result in appreciable economies to both consumer and manufacturer. The variety of ranges and combination of units now available on the market is almost unbelievable. The economies of standardization are obvious.

**Measuring devices.**

Almost every engineer has his own ideas as to the type of instruments he feels most suitable for his survey work. Because he is interested primarily only in comparative readings, he is reasonably safe so long as his instruments retain a fair degree of accuracy. When discussing his problems with another engineer or when conducting a joint survey, it is highly probable that appreciable discrepancies will develop. There is a definite need, therefore, for a comprehensive and organized study of measuring devices and methods as applied to electrolysis work.

**Ground beds.**

Properly designed ground beds of reasonably

*Frank E. Hangs, "Maintain System of Records to Combat Pipe-Line Corrosion," The Oil and Gas Journal 37 (50) 25 (1939).


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Fig. 177 1000-lb. Test
Fig. 192 1600-lb. Test

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low resistance are one of the major problems confronting the cathodic-protection engineer. It is doubtful whether two identical ground beds could be found among the 542 or more listed. Although it is admitted that identical or even standardized ground beds are not desirable, it must be admitted that an intensive study of ground-bed locations, forms, methods of installation, and efficiencies is highly desirable. There is little doubt that many of the now-existent cathodic installations are affected adversely by their ground-bed installation. An organized study and exchange of information cleared through a suitable group would produce worthwhile results.

**Parallel and crossing lines.**

The handling of the manifold problems involved through the joint survey of parallel or crossing pipe lines, or an involvement with other facilities, could be facilitated greatly by organizing the work in such a way and on such a basis as would provide an incentive for each company to cooperate and include a standard and efficient procedure. Herein would be involved the standardization of instruments, procedure, terminology, etc., which would be essential to the full understanding of results and recommendations of all involved parties. Such cases are bound to become more and more frequent, and it is well to consider now how they best may be handled.

**Bonding.**

Table 7 indicates clearly to what extent bonding of crossing lines already is practiced. Because of the grave possibility of serious damage accruing, or allegedly accruing, to one or possibly both lines, and because of the possibility that this would result in legal involvement, bonding practice becomes one of the most serious problems a cathodic engineer must face. The multiplicity of possible conditions arising at a point of bonding hardly can be discussed here; they are, however, all to familiar to the electrolysis engineer. Suffice it to say that there is a definite need for a thorough study of the phenomena resulting from the bonding together of two or more lines. Surely an understanding of the possibilities, not to say respon-

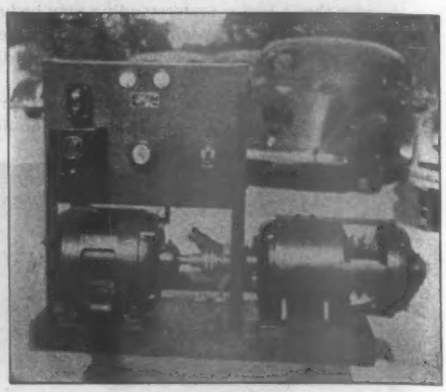

*Fig. 4—Cathodic motor-generator set*

sibilities, would result in some standardization of procedure—with the likelihood that unpleasant legal involvement would be eliminated.

**Insulating flanges.**

Flanges of high di-electric strength, called "insulating flanges," are used frequently in cathodic work to isolate electrically one system from another, or part of a system from the whole. Several companies have evolved their own design for this service, and such designs or their methods of installation are not mutually acceptable. It would be a relatively simple matter to agree upon a standard design and basic method of installation, provided this could be passed upon by an authoritative group.

**Joint installations.**

Joint installations of cathodic units between companies having mutually involved facilities are becoming more frequent. Satisfactory arrangements as to division of installation, maintenance, and operating costs have been made; but there always has been a question as to whether the arrangements were entirely equable. Should the division of installation cost, or the operating cost, be made on the basis of individual amperage consumed or upon that of equivalent miles of pipe protected; or would some other arrangement be more fair? The bogy of entangling alliances is always present. An impartial analysis by a competent group should help to clear up many points on this problem.

**Bibliography.**

Early in its organization the Mid-Continent Cathodic Protection Association felt the need and desire of the industry for a fuller understanding of the entire problem of cathodic protection. It was handicapped by the lack of availability of concrete information, as well as by a lack of funds properly to disseminate the information available. It was felt that joint discussions would be most helpful; but, as the work and expense of organizing such meetings fell to the lot of only a few representatives, such meetings of necessity were curtailed. Through the efforts of a few individuals, the association was able to compile and distribute a fairly complete bibliography. . . .

Many favorable comments have been received on this effort, and it is felt that the work should be expanded and maintained. Surely healthy publicity and the wide dissemination of the knowledge and works on this subject must redound to the benefit of all.

**Terminology.**

A universal terminology is of inestimable value in the free discussion of any technical subject. The recognition of cathodic work in the field al-

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ready has resulted in such gems as "termite" for the electrolysis engineer, and "rust pump" for a cathodic unit; but among the engineers themselves there is still some lack of uniformity as to the technical description of the state of the facilities.

Variations in the meaning of pipe to soil potentials may be expressed confusingly due to using different reference electrodes or by using the net-potential reading instead of the full-potential reading. The resistance of two meters used in taking comparable readings may be different; the position of the electrode with respect to the pipe may have varied materially. Such differences readily may lead to misunderstandings during discussions. It would not be a difficult matter for a suitable committee to investigate, discuss, and publish a bulletin establishing a universal terminology.

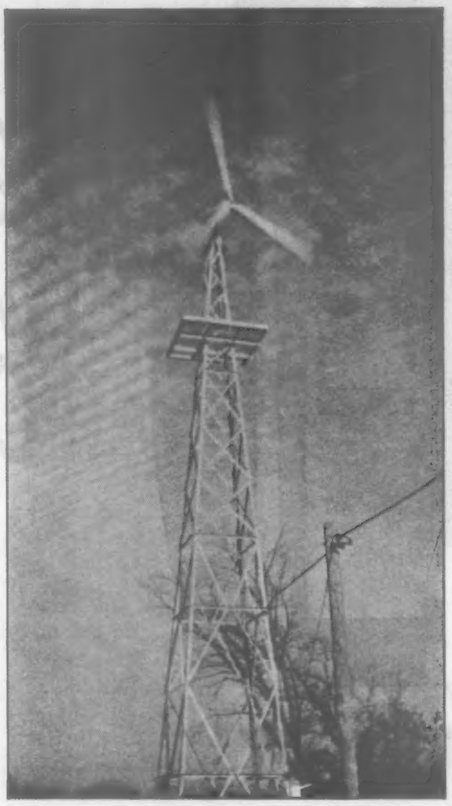

*Fig. 5—Wind-power generator installation*

The protection of pipe lines by means of cathodic units is not just a theory—it is a successful practice of at least 26 companies. More than 2,000 miles of pipe and hundreds of steel storage tanks now are protected in this manner.

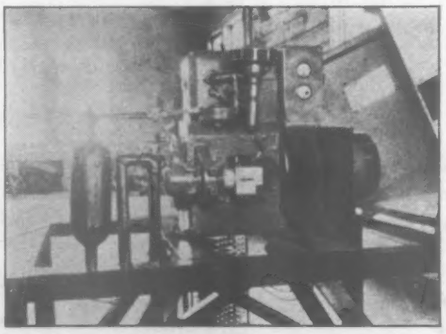

*Fig. 6—Gas-engined generator set*

## Conclusion

There is little doubt that this means of protection would be used by many more operators—especially the smaller ones, who have no corrosion engineer—if they were certain of what they were doing. The industry has wasted much money on this work in the past, due primarily to lack of adequate information and because of duplication of experiments. It should be protected from more needless expenditure.

These problems of electrolysis surveying and cathodic protection of underground structures are concerned intimately with the maintenance of continuity of pipe-line transportation service. Any effort expended toward improving the efficiency and dependability of this branch of the petroleum industry would seem properly to be a concern of the American Petroleum Institute.

The rapid increase in recognition and general use of this form of protection indicates clearly that the mutual problems arising soon will reach the point where they can no longer be handled amicably through individual agreement. The promiscuous use of this protection, especially when multiple lines are involved, very easily can create a hazard. Because of the tremendous liabilities which may be created through lack of understanding, good practice, or standardization, the adequate administration of this work soon may become a serious concern of the entire industry.

In its capacity as clearing house on problems of mutual concern to the petroleum industry, the American Petroleum Institute peculiarly is suited to act as the medium through which this rapidly growing technological work may be organized and studied. Certainly the resources and manpower available through the Institute place it in a far better position to investigate this entire matter—more particularly the technical and practical problems involved such as standard terminology, recommended standards on methods and equipment, and the many kindred problems—than would be possible through any other institution.

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# Partial Volumetric Behavior of Lighter Paraffin Hydrocarbons in the Gas Phase - A.P.I. Research Project 37

By B. H. SAGE and W. N. LACEY
California Institute of Technology, Pasadena, Calif.

A.P.I. — Presented before annual meeting, Chicago, Ill., November 13-17, 1939

THE prediction of the volumetric behavior of complex hydrocarbon gases is of value in many industrial calculations. A number of attempts have been made to predict such behavior for both simple and complex gaseous mixtures. Beattie[1] proposed the use of an equation of state in which the constants were related simply to the composition. This method was found to yield results in accord with experimental data for mixtures of nitrogen and methane.[2] Masson and Dolley[3] attempted to relate the pressure exerted by a gaseous mixture to that exerted by the components individually at the same temperature and total volume. Gilliland[4] proposed a method of predicting the volumetric behavior of gaseous mixtures involving the correlation of the slopes and intercepts of the isochors of the components on a pressure-temperature diagram. This method appears to yield satisfactory results in the case wherein the components exist in the gas phase in the pure state when at the same temperature and molal volume as for the mixture. Another general method of attack proposed by Kay[5] involved the estimation of the "pseudo-critical state" for the gas in question and the subsequent estimation of its volumetric behavior from the law of corresponding states.

In the present paper a somewhat different approach has been attempted. The behavior of a number of the lighter components of naturally occurring gaseous hydrocarbons in several binary mixtures has been studied. These data afford an incomplete empirical background upon which to base a method of prediction of the behavior of complex hydrocarbon mixtures. It should be realized that at the present time there are insufficient data to permit such predictions to be made with accuracy.

## General Considerations

In considering the volumetric behavior of gaseous mixtures in terms related to the behavior of their components, it is convenient to employ partial quantities.[6] Such quantities have been proposed already for the correlation of the volumetric behavior of complex hydrocarbon mixtures in the liquid phase.[7] The partial specific volume of any component $k$, as it will be employed in the present discussion, may be defined by the following equation:*

$$\bar{V}_k = \left(\frac{\partial V}{\partial m_k}\right)_{T,P,m_i} \qquad (1)$$

Equation 1 indicates that a partial specific volume represents the change in volume of a large quantity of a system of variable weight under isothermal, isobaric conditions due to the addition of a unit weight of the component in question. The equation stipulates by the use of the subscript $m_i$ that the weight of all components other than component $k$ must be maintained constant during the change in state.

It follows from the definition of a partial quantity that the specific volume of a mixture is related to the composition and the partial specific volume of each of the components by means of an equation of the following form[8]:

$$V = \sum_{k=1}^{k=n} \bar{V}_k n_k = \bar{V}_1 n_1 + \bar{V}_2 n_2 + \ldots + \bar{V}_n n_n \qquad (2)$$

In order that Equation 2 may be applicable, it is necessary that the partial volume used for each component be the value applying to the mixture at the state in question. Strictly speaking, the partial volume of a component is a function of the state of the phase, and varies, therefore, with changes in any of the variables which establish this state.

In the case of gases, the partial specific volumes

TABLE 1—RESIDUAL PARTIAL SPECIFIC VOLUMES IN THE GAS PHASE OF THE METHANE-ETHANE SYSTEM

| Temperature (°F.) | Pressure* (lb. per sq. in.) | METHANE Weight per cent methane as follows: 60 | 70 | 80 | 90 | 100 | ETHANE Weight per cent ethane as follows: 0 | 10 | 20 | 30 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | 0 | †0.050 | 0.0474 | 0.0458 | 0.0451 | 0.0449 | 0.1121 | 0.0972 | 0.0875 | 0.0831 | 0.0811 |
| | 250 | 0.0478 | 0.0465 | 0.0452 | 0.0446 | 0.0443 | 0.1123 | 0.0990 | 0.0911 | 0.0886 | 0.0891 |
| | 500 | 0.0458 | 0.0455 | 0.0445 | 0.0439 | 0.0436 | 0.1121 | 0.1004 | 0.0942 | 0.0927 | 0.0945 |
| | 750 | 0.0438 | 0.0445 | 0.0436 | 0.0427 | 0.0424 | 0.1112 | 0.1024 | 0.0967 | 0.0950 | 0.0974 |
| | 1,000 | 0.0423 | 0.0434 | 0.0424 | 0.0413 | 0.0410 | 0.1093 | 0.1027 | 0.0980 | 0.0960 | 0.0982 |
| | 1,500 | 0.0410 | 0.0406 | 0.0389 | 0.0377 | 0.0374 | 0.1016 | 0.0990 | 0.0948 | 0.0914 | 0.0917 |
| | 2,000 | 0.0384 | 0.0366 | 0.0344 | 0.0331 | 0.0329 | 0.0891 | 0.0843 | 0.0816 | 0.0744 | 0.0732 |
| | 2,500 | 0.0332 | 0.0309 | 0.0292 | 0.0278 | 0.0272 | 0.0752 | 0.0692 | 0.0624 | 0.0570 | 0.0528 |
| | 3,000 | 0.0274 | 0.0250 | 0.0232 | 0.0218 | 0.0211 | 0.0614 | 0.0537 | 0.0470 | 0.0415 | 0.0368 |
| 100 | 0 | 0.046 | 0.0431 | 0.0403 | 0.0386 | 0.0379 | 0.1069 | 0.0913 | 0.0808 | 0.0745 | 0.0706 |
| | 250 | 0.0434 | 0.0417 | 0.0395 | 0.0380 | 0.0373 | 0.1053 | 0.0916 | 0.0824 | 0.0779 | 0.0766 |
| | 500 | 0.0412 | 0.0405 | 0.0386 | 0.0371 | 0.0366 | 0.1033 | 0.0916 | 0.0838 | 0.0808 | 0.0808 |
| | 750 | 0.0391 | 0.0390 | 0.0375 | 0.0362 | 0.0357 | 0.1008 | 0.0910 | 0.0846 | 0.0822 | 0.0832 |
| | 1,000 | 0.0373 | 0.0377 | 0.0362 | 0.0348 | 0.0344 | 0.0980 | 0.0900 | 0.0846 | 0.0828 | 0.0841 |
| | 1,500 | 0.0344 | 0.0344 | 0.0328 | 0.0316 | 0.0313 | 0.0905 | 0.0852 | 0.0812 | 0.0788 | 0.0803 |
| | 2,000 | 0.0311 | 0.0304 | 0.0287 | 0.0276 | 0.0274 | 0.0800 | 0.0755 | 0.0718 | 0.0687 | 0.0681 |
| | 2,500 | 0.0270 | 0.0256 | 0.0243 | 0.0232 | 0.0227 | 0.0692 | 0.0632 | 0.0585 | 0.0555 | 0.0524 |
| | 3,000 | 0.0229 | 0.0208 | 0.0194 | 0.0183 | 0.0176 | 0.0586 | 0.0518 | 0.0462 | 0.0416 | 0.0379 |
| 130 | 0 | 0.042 | 0.0388 | 0.0354 | 0.0332 | 0.0322 | 0.103 | 0.0868 | 0.0748 | 0.0668 | 0.0624 |
| | 250 | 0.0394 | 0.0373 | 0.0346 | 0.0326 | 0.0317 | 0.0997 | 0.0860 | 0.0757 | 0.0690 | 0.0652 |
| | 500 | 0.0371 | 0.0359 | 0.0336 | 0.0319 | 0.0310 | 0.0964 | 0.0847 | 0.0756 | 0.0708 | 0.0678 |
| | 750 | 0.0349 | 0.0343 | 0.0324 | 0.0308 | 0.0300 | 0.0931 | 0.0833 | 0.0756 | 0.0718 | 0.0699 |
| | 1,000 | 0.0330 | 0.0327 | 0.0310 | 0.0296 | 0.0289 | 0.0897 | 0.0827 | 0.0748 | 0.0720 | 0.0712 |
| | 1,500 | 0.0293 | 0.0288 | 0.0276 | 0.0265 | 0.0260 | 0.0821 | 0.0750 | 0.0711 | 0.0690 | 0.0699 |
| | 2,000 | 0.0257 | 0.0249 | 0.0239 | 0.0232 | 0.0226 | 0.0732 | 0.0672 | 0.0634 | 0.0617 | 0.0616 |
| | 2,500 | 0.0222 | 0.0210 | 0.0199 | 0.0192 | 0.0187 | 0.0642 | 0.0590 | 0.0542 | 0.0514 | 0.0494 |
| | 3,000 | 0.0192 | 0.0172 | 0.0159 | 0.0154 | 0.0145 | 0.0558 | 0.0508 | 0.0448 | 0.0392 | 0.0351 |
| 160 | 0 | 0.037 | 0.0339 | 0.0312 | 0.0290 | 0.0278 | 0.1003 | 0.0822 | 0.0695 | 0.0607 | 0.0556 |
| | 250 | 0.0359 | 0.0329 | 0.0302 | 0.0284 | 0.0272 | 0.0958 | 0.0808 | 0.0695 | 0.0617 | 0.0577 |
| | 500 | 0.0336 | 0.0314 | 0.0292 | 0.0276 | 0.0265 | 0.0915 | 0.0790 | 0.0692 | 0.0627 | 0.0595 |
| | 750 | 0.0313 | 0.0300 | 0.0280 | 0.0266 | 0.0255 | 0.0872 | 0.0767 | 0.0685 | 0.0631 | 0.0609 |
| | 1,000 | 0.0292 | 0.0280 | 0.0266 | 0.0254 | 0.0243 | 0.0832 | 0.0744 | 0.0674 | 0.0631 | 0.0618 |
| | 1,500 | 0.0254 | 0.0245 | 0.0233 | 0.0225 | 0.0215 | 0.0755 | 0.0686 | 0.0633 | 0.0605 | 0.0605 |
| | 2,000 | 0.0217 | 0.0208 | 0.0199 | 0.0191 | 0.0185 | 0.0676 | 0.0613 | 0.0569 | 0.0544 | 0.0540 |
| | 2,500 | 0.0185 | 0.0174 | 0.0164 | 0.0157 | 0.0151 | 0.0600 | 0.0542 | 0.0497 | 0.0466 | 0.0448 |
| | 3,000 | 0.0159 | 0.0138 | 0.0128 | 0.0120 | 0.0114 | 0.0531 | 0.0472 | 0.0421 | 0.0390 | 0.0351 |
| 190 | 0 | 0.035 | 0.0316 | 0.0279 | 0.0254 | 0.0237 | 0.0963 | 0.0790 | 0.0648 | 0.0553 | 0.0498 |
| | 250 | 0.0326 | 0.0299 | 0.0267 | 0.0248 | 0.0233 | 0.0928 | 0.0766 | 0.0642 | 0.0558 | 0.0512 |
| | 500 | 0.0304 | 0.0282 | 0.0255 | 0.0238 | 0.0226 | 0.0876 | 0.0744 | 0.0637 | 0.0563 | 0.0524 |
| | 750 | 0.0283 | 0.0265 | 0.0242 | 0.0227 | 0.0216 | 0.0827 | 0.0716 | 0.0628 | 0.0564 | 0.0533 |
| | 1,000 | 0.0263 | 0.0247 | 0.0227 | 0.0213 | 0.0204 | 0.0783 | 0.0690 | 0.0615 | 0.0566 | 0.0537 |
| | 1,500 | 0.0224 | 0.0212 | 0.0194 | 0.0182 | 0.0177 | 0.0702 | 0.0630 | 0.0573 | 0.0536 | 0.0520 |
| | 2,000 | 0.0187 | 0.0178 | 0.0162 | 0.0152 | 0.0148 | 0.0628 | 0.0564 | 0.0515 | 0.0483 | 0.0468 |
| | 2,500 | 0.0155 | 0.0145 | 0.0131 | 0.0121 | 0.0118 | 0.0558 | 0.0501 | 0.0453 | 0.0417 | 0.0395 |
| | 3,000 | 0.0129 | 0.0117 | 0.0100 | 0.0089 | 0.0085 | 0.0498 | 0.0437 | 0.0386 | 0.0347 | 0.0321 |
| 220 | 0 | 0.032 | 0.0288 | 0.0251 | 0.0224 | 0.0201 | 0.0964 | 0.0758 | 0.0608 | 0.0503 | 0.0445 |
| | 250 | 0.0296 | 0.0268 | 0.0237 | 0.0214 | 0.0198 | 0.0902 | 0.0730 | 0.0600 | 0.0507 | 0.0455 |
| | 500 | 0.0275 | 0.0250 | 0.0222 | 0.0204 | 0.0191 | 0.0841 | 0.0702 | 0.0590 | 0.0509 | 0.0463 |
| | 750 | 0.0255 | 0.0232 | 0.0207 | 0.0192 | 0.0181 | 0.0787 | 0.0669 | 0.0577 | 0.0510 | 0.0468 |
| | 1,000 | 0.0235 | 0.0215 | 0.0193 | 0.0180 | 0.0170 | 0.0739 | 0.0642 | 0.0562 | 0.0503 | 0.0468 |
| | 1,500 | 0.0196 | 0.0178 | 0.0162 | 0.0153 | 0.0145 | 0.0656 | 0.0580 | 0.0518 | 0.0474 | 0.0450 |
| | 2,000 | 0.0161 | 0.0148 | 0.0132 | 0.0123 | 0.0117 | 0.0584 | 0.0518 | 0.0466 | 0.0427 | 0.0404 |
| | 2,500 | 0.0128 | 0.0117 | 0.0103 | 0.0094 | 0.0089 | 0.0522 | 0.0468 | 0.0409 | 0.0371 | 0.0345 |
| | 3,000 | 0.0103 | 0.0089 | 0.0075 | 0.6066 | 0.0059 | 0.0465 | 0.0408 | 0.0351 | 0.0310 | 0.0285 |
| 250 | 0 | 0.030 | 0.0266 | 0.0225 | 0.0193 | 0.0170 | 0.0946 | 0.0734 | 0.0574 | 0.0462 | 0.0398 |
| | 250 | 0.0276 | 0.0248 | 0.0209 | 0.0182 | 0.0166 | 0.0876 | 0.0700 | 0.0562 | 0.0462 | 0.0407 |
| | 500 | 0.0254 | 0.0227 | 0.0194 | 0.0171 | 0.0160 | 0.0812 | 0.0668 | 0.0549 | 0.0462 | 0.0413 |
| | 750 | 0.0234 | 0.0209 | 0.0179 | 0.0159 | 0.0150 | 0.0753 | 0.0636 | 0.0533 | 0.0457 | 0.0416 |
| | 1,000 | 0.0213 | 0.0191 | 0.0164 | 0.0146 | 0.0140 | 0.0701 | 0.0602 | 0.0515 | 0.0449 | 0.0414 |
| | 1,500 | 0.0174 | 0.0155 | 0.0134 | 0.0121 | 0.0114 | 0.0613 | 0.0536 | 0.0470 | 0.0419 | 0.0392 |
| | 2,000 | 0.0137 | 0.0124 | 0.0105 | 0.0092 | 0.0087 | 0.0541 | 0.0472 | 0.0415 | 0.0373 | 0.0350 |
| | 2,500 | 0.0105 | 0.0095 | 0.0078 | 0.0066 | 0.0061 | 0.0479 | 0.0414 | 0.0362 | 0.0320 | 0.0298 |
| | 3,000 | 0.0079 | 0.0067 | 0.0052 | 0.0039 | 0.0034 | 0.0427 | 0.0363 | 0.0311 | 0.0267 | 0.0244 |

*All pressures are in pounds per square inch, absolute.
†Residual partial specific volume, cubic feet per pound.

*See nomenclature.

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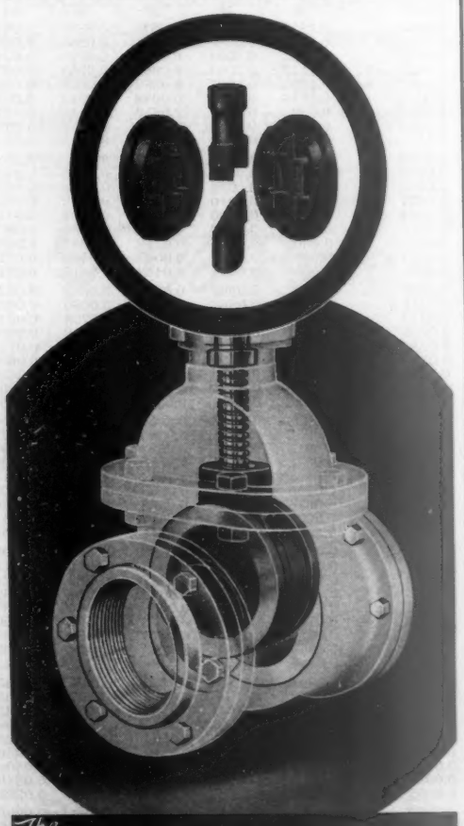

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of the components undergo large changes with variations of both temperature and pressure. For this reason it is advantageous to employ "residual methods." In the case of gas phases, the residual volume conveniently is defined in relation to the specific volume, and the reference volume by means of the following relationship:

$$V = V_R - \underline{V} = \frac{bT}{P} - \underline{V} \qquad (3)$$

If it is desired to consider a system of variable weight, Equation 3 assumes the following form:

$$\underline{V} = \frac{mbT}{P} - m\underline{V} \qquad (4)$$

If Equation 4 is applied to the $n$-component system of variable weight, it may be rewritten in the expanded form:

$$\underline{V} = (m_i b_i + m_k b_k)\frac{T}{P} - (m_i + m_k)\underline{V} \qquad (5)$$

If Equation 5 is differentiated while holding constant the temperature, pressure, and weight of all components other than component $k$, the following relationship is obtained in Equation 6:

$$\overline{V}_k = \left(\frac{\partial V}{\partial m_k}\right)_{T,P,m_i} = \frac{b_k T}{P} - \underline{V} - (m_i + m_k)\left(\frac{\partial \underline{V}}{\partial m_k}\right)_{T,P,m_i} \qquad (6)$$

By suitable substitution Equation 6 may be rewritten in the following more useful form:

$$\overline{V}_k = \frac{b_k T}{P} - \left[\underline{V} + (1 - n_k)\left(\frac{\partial \underline{V}}{\partial n_k}\right)_{T,P}\right] \qquad (7)$$

It is of interest to investigate the geometric signifcance of the portion of this equation included in the brackets. In Fig. 1 are presented the residual volumes for mixtures of methane and ethane at 160° F. for a series of pressures.[9] These data indicate significant departures from the behavior of ideal solutions even at infinite attenuation. The line *AB* is drawn tangent to the isobar for 1,000 lb. per sq. in. at a composition of 60 weight per cent methane. The ordinate value of the intercept *A*, which corresponds to the composition of pure methane, is equal to the terms within the brackets of Equation 7 when methane is taken as component $k$. This follows, since the ordinate at the point of tangency is the residual volume at this state, whereas the slope of the line *AB* is equal to $\left(\frac{\partial \underline{V}}{\partial n_k}\right)_{T,P}$ and the distance from the point of tangency to the right-hand ordinate corresponds to the term $1 - n_k$. From this geometry of the figure it is then evident that the intercept ordinate value is equivalent to the sum of the last two terms in question.

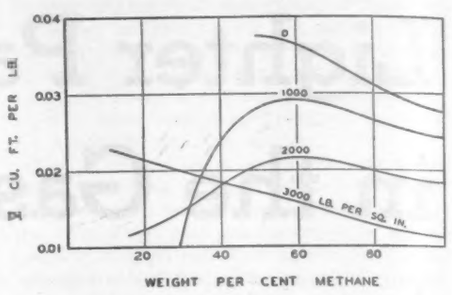


***Fig. 1—Residual specific volumes for the methane-ethane system at 160° F.***

For convenience, and by analogy from specific partial quantities, such an intercept value[10] will be called the "residual partial specific volume." In this instance the intercept with the right-hand ordinate is the residual partial specific volume of methane in the gas phase of the methane-ethane system at a composition of 60 weight per cent methane and at 1,000 lb. per sq. in. and 160° F. Likewise the intercept with the left-hand ordinate corresponding to pure ethane would be the residual partial specific volume of ethane in the same system at the same state. Equation 7 may be rewritten in the following simple form:

$$\overline{V}_k = \frac{b_k T}{P} - \overline{\underline{V}}_k \qquad (8)$$

The residual partial specific volumes of the components of gaseous mixtures are convenient quantities to employ, as they do not vary greatly with either temperature or pressure and, therefore, permit the use of relatively simple inter-

**TABLE 2—RESIDUAL PARTIAL SPECIFIC VOLUMES IN THE GAS PHASE OF THE METHANE-PROPANE SYSTEM**

| Temperature (°F.) | Pressure (lb. per sq. in.) | METHANE Weight per cent methane as follows: 60 | 70 | 80 | 90 | 100 | PROPANE Weight per cent propane as follows: 0 | 10 | 20 | 30 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | 0 | *0.045 | 0.045 | 0.045 | 0.045 | 0.0449 | 0.131 | 0.131 | 0.131 | 0.131 | 0.131 |
| | 250 | 0.041 | 0.042 | 0.044 | 0.044 | 0.0443 | 0.118 | 0.122 | 0.125 | 0.128 | 0.131 |
| | 500 | 0.039 | 0.040 | 0.042 | 0.043 | 0.0436 | 0.107 | 0.113 | 0.118 | 0.123 | 0.127 |
| | 750 | 0.037 | 0.039 | 0.041 | 0.042 | 0.0424 | 0.099 | 0.105 | 0.111 | 0.116 | 0.121 |
| | 1,000 | 0.035 | 0.037 | 0.039 | 0.041 | 0.0410 | 0.091 | 0.098 | 0.104 | 0.109 | 0.113 |
| | 1,500 | 0.032 | 0.034 | 0.036 | 0.037 | 0.0374 | 0.075 | 0.083 | 0.089 | 0.094 | 0.098 |
| | 2,000 | 0.029 | 0.030 | 0.031 | 0.032 | 0.0329 | 0.059 | 0.067 | 0.072 | 0.076 | 0.077 |
| | 2,500 | 0.027 | 0.026 | 0.026 | 0.027 | 0.0272 | 0.049 | 0.051 | 0.052 | 0.054 | 0.055 |
| | 3,000 | 0.024 | 0.022 | 0.021 | 0.021 | 0.0211 | 0.041 | 0.040 | 0.038 | 0.035 | 0.032 |
| 100 | 0 | 0.038 | 0.038 | 0.038 | 0.038 | 0.0379 | 0.116 | 0.116 | 0.116 | 0.116 | 0.116 |
| | 250 | 0.035 | 0.036 | 0.037 | 0.037 | 0.0373 | 0.103 | 0.106 | 0.110 | 0.114 | 0.119 |
| | 500 | 0.032 | 0.034 | 0.036 | 0.036 | 0.0366 | 0.093 | 0.097 | 0.103 | 0.111 | 0.118 |
| | 750 | 0.029 | 0.032 | 0.034 | 0.035 | 0.0357 | 0.082 | 0.089 | 0.097 | 0.106 | 0.116 |
| | 1,000 | 0.027 | 0.031 | 0.033 | 0.034 | 0.0344 | 0.074 | 0.081 | 0.089 | 0.099 | 0.111 |
| | 1,500 | 0.023 | 0.027 | 0.030 | 0.031 | 0.0313 | 0.061 | 0.067 | 0.075 | 0.084 | 0.094 |
| | 2,000 | 0.020 | 0.021 | 0.026 | 0.027 | 0.0274 | 0.050 | 0.057 | 0.061 | 0.066 | 0.067 |
| | 2,500 | 0.018 | 0.023 | 0.022 | 0.023 | 0.0227 | 0.041 | 0.045 | 0.044 | 0.051 | 0.052 |
| | 3,000 | 0.018 | 0.017 | 0.017 | 0.018 | 0.0176 | 0.032 | 0.033 | 0.034 | 0.034 | 0.032 |
| 130 | 0 | 0.032 | 0.032 | 0.032 | 0.032 | 0.0322 | 0.104 | 0.104 | 0.104 | 0.104 | 0.104 |
| | 250 | 0.030 | 0.031 | 0.031 | 0.031 | 0.0317 | 0.091 | 0.093 | 0.095 | 0.098 | 0.101 |
| | 500 | 0.027 | 0.029 | 0.030 | 0.030 | 0.0310 | 0.081 | 0.084 | 0.088 | 0.093 | 0.098 |
| | 750 | 0.025 | 0.028 | 0.029 | 0.029 | 0.0300 | 0.072 | 0.076 | 0.081 | 0.087 | 0.094 |
| | 1,000 | 0.023 | 0.026 | 0.027 | 0.028 | 0.0289 | 0.065 | 0.070 | 0.075 | 0.082 | 0.090 |
| | 1,500 | 0.019 | 0.023 | 0.025 | 0.026 | 0.0260 | 0.053 | 0.058 | 0.064 | 0.071 | 0.078 |
| | 2,000 | 0.016 | 0.019 | 0.021 | 0.022 | 0.0226 | 0.043 | 0.048 | 0.054 | 0.059 | 0.064 |
| | 2,500 | 0.014 | 0.015 | 0.018 | 0.019 | 0.0187 | 0.034 | 0.039 | 0.043 | 0.046 | 0.048 |
| | 3,000 | 0.014 | 0.014 | 0.014 | 0.014 | 0.0145 | 0.027 | 0.029 | 0.031 | 0.032 | 0.033 |
| 160 | 0 | 0.028 | 0.028 | 0.028 | 0.028 | 0.0278 | 0.094 | 0.094 | 0.094 | 0.094 | 0.094 |
| | 250 | 0.026 | 0.027 | 0.027 | 0.027 | 0.0272 | 0.084 | 0.083 | 0.084 | 0.085 | 0.087 |
| | 500 | 0.024 | 0.025 | 0.026 | 0.026 | 0.0265 | 0.075 | 0.076 | 0.077 | 0.079 | 0.083 |
| | 750 | 0.022 | 0.024 | 0.025 | 0.025 | 0.0255 | 0.068 | 0.070 | 0.072 | 0.075 | 0.076 |
| | 1,000 | 0.020 | 0.022 | 0.023 | 0.024 | 0.0243 | 0.062 | 0.064 | 0.066 | 0.069 | 0.074 |
| | 1,500 | 0.017 | 0.019 | 0.021 | 0.021 | 0.0215 | 0.050 | 0.053 | 0.057 | 0.061 | 0.066 |
| | 2,000 | 0.014 | 0.017 | 0.018 | 0.018 | 0.0185 | 0.041 | 0.045 | 0.049 | 0.053 | 0.057 |
| | 2,500 | 0.012 | 0.014 | 0.015 | 0.015 | 0.0151 | 0.034 | 0.037 | 0.040 | 0.043 | 0.045 |
| | 3,000 | 0.010 | 0.011 | 0.011 | 0.011 | 0.0114 | 0.027 | 0.029 | 0.031 | 0.032 | 0.033 |
| 190 | 0 | 0.024 | 0.024 | 0.024 | 0.024 | 0.0237 | 0.085 | 0.085 | 0.085 | 0.085 | 0.085 |
| | 250 | 0.022 | 0.023 | 0.023 | 0.023 | 0.0233 | 0.078 | 0.077 | 0.076 | 0.077 | 0.079 |
| | 500 | 0.021 | 0.022 | 0.023 | 0.023 | 0.0226 | 0.072 | 0.070 | 0.070 | 0.071 | 0.074 |
| | 750 | 0.020 | 0.021 | 0.022 | 0.022 | 0.0216 | 0.067 | 0.065 | 0.065 | 1.066 | 0.070 |
| | 1,000 | 0.018 | 0.020 | 0.020 | 0.020 | 0.0204 | 0.061 | 0.060 | 0.060 | 0.062 | 0.066 |
| | 1,500 | 0.016 | 0.017 | 0.018 | 0.018 | 0.0177 | 0.050 | 0.050 | 0.052 | 0.054 | 0.058 |
| | 2,000 | 0.013 | 0.014 | 0.015 | 0.015 | 0.0148 | 0.040 | 0.042 | 0.044 | 0.046 | 0.049 |
| | 2,500 | 0.011 | 0.011 | 0.011 | 0.012 | 0.0118 | 0.033 | 0.035 | 0.037 | 0.038 | 0.040 |
| | 3,000 | 0.009 | 0.009 | 0.008 | 0.008 | 0.0085 | 0.029 | 0.030 | 0.031 | 0.031 | 0.031 |

*Residual partial specific volume, cubic feet per pound.

polation. In addition, this quantity represents only a small part of the partial specific volume, and this reduces the need for high-percentage accuracy in its estimation.

A combination of Equations 2 and 8 yields the following expression for the specific volume of a multicomponent gaseous mixture in terms of its composition and the residual partial specific volumes of the components:

$$V=\sum_{k=1}^{k=n}\left(\frac{b_k T}{P}-\bar{V}_k\right)n_k \qquad (9)$$

From a consideration of Equation 9 and Fig. 1 it is apparent that, at low pressures, the first term which corresponds to the perfect gas volume of the mixture contributes a large fraction of the whole. Therefore, at low pressures the volume of hydrocarbon gases may be predicted with reasonable accuracy, even though there is rather a large percentage uncertainty in the establishment of the residual partial specific volume of the components.

## Experimental Background

In order to make use of the relationships derived in the preceding section, it is necessary to have a knowledge of the partial volumetric behavior of each of the components as a function of the state of the gaseous mixture in question. At the present time there are no data available to the authors relating to the partial specific

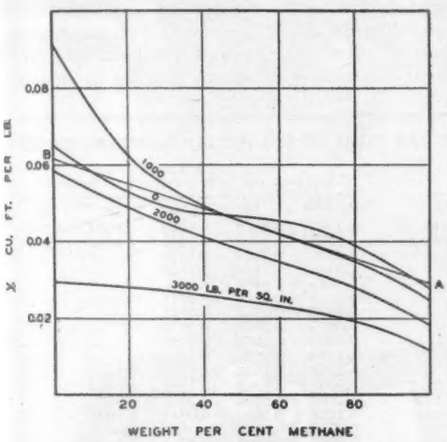


*Fig. 2—Residual partial specific volumes for methane in the methane-ethane system at 160° F.*

volume of the lighter components in complex hydrocarbon mixtures. However, information concerning the behavior of a number of binary gaseous-hydrocarbon mixtures has become available recently.[11,12,13] As a tentative procedure it is possible to consider the partial volumetric behavior of the lighter paraffin-hydrocarbon constituents in these binary systems as directly applicable to the behavior of complex hydrocarbon gases. It should be realized that this assumption inevitably introduces errors in the resulting predictions of the specific volume of the complex mixtures. However, it is believed that such uncertainties are sufficiently small in many instances to make the predictions of engineering value. Furthermore, the method will increase in value as more experimental knowledge of partial volumetric behavior accumulates.

Experimental data are available concerning the volumetric behavior of pure methane,[3,14] ethane,[15,16] propane,[17,18] and *n*-butane[19,20] in the gaseous region throughout the temperature interval of interest in petroleum-production practice. These data serve to establish the behavior in the pure state of these important constituents of dry natural gases with an accuracy adequate for most engineering purposes.

The behavior of mixtures of methane and ethane throughout the entire composition range at pressures up to 3,000 lb. per sq. in. in the temperature interval between 70 and 250° F. is known.[13] These data have been employed in the present instance to establish the partial volumetric behavior of methane and of ethane in the methane-ethane system. The residual partial specific volume of methane in this system is presented in Fig. 2 as a function of composition at 160° F. The residual partial specific volume of methane is equal to its residual specific volume when the system is composed solely of methane. The values of the residual specific volume of methane were obtained from the measurements of Kvalnes and Gaddy.[14] These data for pure methane are in satisfactory agreement with extrapolations of the partial volumetric behavior of methane in the methane-ethane system. The residual partial specific volumes of methane and ethane in the methane-ethane system are recorded in Table 1 as a function of pressure, temperature, and the weight fraction of the component. The experimental data[13] indicate that these gaseous mixtures do not follow the laws of ideal solutions strictly even at relatively low pressures, although the percentage deviation is small.

Some experimental information is available concerning the behavior of mixtures of methane and propane[21] in the gaseous region throughout an appreciable range of temperatures and pressures. These data are not of high accuracy, but it is believed that the partial volumetric behaviors of methane and propane derived from them are of engineering value. Although the precision of measurement was sufficient to yield reasonably consistent residual partial specific volumes, there may be appreciable absolute uncertainties in the values. The volumetric data have been made to conform to the laws of ideal solutions at infinite attenuation. This was done because of the relatively large uncertainties in the experimental work on this system at low pressures. The residual partial volumetric behavior of methane and


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propane in the methane-propane system is recorded in Table 2. The values given cover the greater part of the composition range likely to be encountered in the gases involved in production practice at pressures below 3,000 lb. per sq. in.

From as yet unpublished data from Research Project 37 concerning the behavior of gaseous mixtures of methane and *n*-butane, the residual partial volumetric behavior of these hydrocarbons has been established. It was experimentally difficult in this case to obtain high accuracy at the lower pressures, due to possible selective adsorption and to other uncertainties. For this reason the methane-*n*-butane system also has been made arbitrarily to conform strictly to the laws of ideal solutions at infinite attenuation. This procedure has not caused significant divergence from the experimental data above 500 lb. per sq. in., and has not involved a change in the partial volumes of either component of more than 2 per cent at any state. The partial volumetric behavior of methane and of *n*-butane in the gas phase of the methane-*n*-butane system has been recorded in Table 3. The composition range has been restricted at the lower temperatures because of the appearance of a liquid phase at compositions slightly richer in *n*-butane than those recorded.

### Tentative Application to Complex Mixtures

The partial specific volume of a component in a multicomponent phase is a function of all the variables necessary to fix the state. Therefore, it is necessary to take into account the nature and amount of all of the other components present in order to ascertain with accuracy the partial specific volume of a component at a given pressure and temperature. At the present time there are insufficient experimental data to take all of these factors into account. Therefore, it seems desirable to employ some arbitrary means of simplifying the method of expressing the composition of the gas so that it may be treated from existing data. As was indicated in the previous section, information is available concerning the partial volumetric behavior of methane, ethane, propane, and *n*-butane in binary gaseous-hydrocarbon systems containing methane. It becomes desirable, therefore, to treat the multi-component system as an equivalent quaternary system.

There are a number of arbitrary methods by which this simplification could be made. In veiw of the scarcity of present information to justify elaboration, a simple method will be chosen for present purposes. All components of greater molecular weight than propane will be considered, mol for mol, as *n*-butane. On this basis the modified mole fraction of butane in the mixture may be evaluated by the equation:

$$\underline{n}'_4 = \sum_{k=4}^{k=n} \underline{n}_k \qquad (10)$$

If the possibility of the presence of nonhydrocarbon gases is neglected,

$$\underline{n}'_4 = 1 - \underline{n}_1 - \underline{n}_2 - \underline{n}_3 \qquad (11)$$

It should be remembered that this arbitrary simplification of the composition of the system inevitably introduces uncertainties in the predictions of volume. As more experimental measurements accumulate, it will be possible to employ

**TABLE 3—RESIDUAL PARTIAL SPECIFIC VOLUMES IN THE GAS PHASE OF THE METHANE-*n*-BUTANE SYSTEM**

| Temperature (°F.) | Pressure (lb. per sq. in.) | METHANE Weight per cent methane as follows: 60 | 70 | 80 | 90 | 100 | *n*-BUTANE Weight per cent *n*-butane as follows: 0 | 10 | 20 | 30 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | 0 | 0.0449* | 0.0449 | 0.0449 | 0.0449 | 0.0449 | 0.1804 | 0.1804 | 0.1804 | 0.1804 | 0.1804 |
| | 250 | 0.0307 | 0.0367 | 0.0405 | 0.0426 | 0.0443 | 0.1378 | 0.1426 | 0.1452 | 0.1562 | 0.1699 |
| | 500 | ..... | ..... | 0.0418 | 0.0428 | 0.0436 | 0.1226 | 0.1305 | 0.1278 | ..... | ..... |
| | 750 | ..... | ..... | 0.0422 | 0.0420 | 0.0424 | 0.1126 | 0.1196 | 0.1156 | ..... | ..... |
| | 1,000 | ..... | ..... | 0.0414 | 0.0412 | 0.0410 | 0.1045 | 0.1100 | 0.1056 | ..... | ..... |
| | 1,500 | ..... | ..... | 0.0382 | 0.0376 | 0.0374 | 0.0914 | 0.0919 | 0.0871 | ..... | ..... |
| | 2,000 | ..... | ..... | 0.0336 | 0.0327 | 0.0329 | 0.0787 | 0.0753 | 0.0717 | ..... | ..... |
| | 2,500 | ..... | ..... | 0.0284 | 0.0271 | 0.0272 | 0.0643 | 0.0605 | 0.0570 | ..... | ..... |
| | 3,000 | ..... | ..... | 0.0226 | 0.0212 | 0.0211 | 0.0503 | 0.0473 | 0.0435 | ..... | ..... |
| 100 | 0 | 0.0379 | 0.0379 | 0.0379 | 0.0379 | 0.0379 | 0.1719 | 0.1719 | 0.1719 | 0.1719 | 0.1719 |
| | 250 | 0.0251 | 0.0319 | 0.0355 | 0.0365 | 0.0373 | 0.1316 | 0.1340 | 0.1387 | 0.1466 | 0.1613 |
| | 500 | ..... | 0.0344 | 0.0362 | 0.0366 | 0.0366 | 0.1201 | 0.1208 | 0.1230 | 0.1246 | ..... |
| | 750 | ..... | 0.0358 | 0.0362 | 0.0363 | 0.0357 | 0.1104 | 0.1096 | 0.1096 | 0.1095 | ..... |
| | 1,000 | ..... | 0.0357 | 0.0357 | 0.0352 | 0.0344 | 0.1028 | 0.1000 | 0.0985 | 0.0975 | ..... |
| | 1,500 | ..... | 0.0335 | 0.0328 | 0.0318 | 0.0313 | 0.0916 | 0.0855 | 0.0808 | 0.0785 | ..... |
| | 2,000 | ..... | 0.0298 | 0.0287 | 0.0275 | 0.0274 | 0.0785 | 0.0704 | 0.0657 | 0.0624 | ..... |
| | 2,500 | ..... | 0.0252 | 0.0239 | 0.0228 | 0.0227 | 0.0626 | 0.0574 | 0.0532 | 0.0492 | ..... |
| | 3,000 | ..... | 0.0203 | 0.0187 | 0.0179 | 0.0176 | 0.0464 | 0.0439 | 0.0416 | 0.0366 | ..... |
| 130 | 0 | 0.0322 | 0.0322 | 0.0322 | 0.0322 | 0.0322 | 0.1630 | 0.1630 | 0.1630 | 0.1630 | 0.1630 |
| | 250 | 0.0218 | 0.0281 | 0.0306 | 0.0314 | 0.0317 | 0.1302 | 0.1295 | 0.1333 | 0.1397 | 0.1521 |
| | 500 | 0.0213 | 0.0289 | 0.0310 | 0.0310 | 0.0310 | 0.1182 | 0.1140 | 0.1129 | 0.1165 | 0.1323 |
| | 750 | 0.0220 | 0.0307 | 0.0309 | 0.0304 | 0.0300 | 0.1092 | 0.1030 | 0.0994 | 0.1010 | 0.1136 |
| | 1,000 | 0.0231 | 0.0305 | 0.0303 | 0.0295 | 0.0289 | 0.1018 | 0.0940 | 0.0889 | 0.0891 | 0.0993 |
| | 1,500 | 0.0241 | 0.0282 | 0.0280 | 0.0269 | 0.0260 | 0.0879 | 0.0781 | 0.0731 | 0.0719 | 0.0779 |
| | 2,000 | 0.0231 | 0.0247 | 0.0245 | 0.0232 | 0.0226 | 0.0747 | 0.0646 | 0.0596 | 0.0578 | 0.0616 |
| | 2,500 | 0.0221 | 0.0206 | 0.0204 | 0.0190 | 0.0187 | 0.0593 | 0.0525 | 0.0485 | 0.0468 | 0.0474 |
| | 3,000 | 0.0180 | 0.0159 | 0.0152 | 0.0147 | 0.0145 | 0.0431 | 0.0408 | 0.0393 | 0.0367 | 0.0334 |
| 160 | 0 | 0.0278 | 0.0278 | 0.0278 | 0.0278 | 0.0278 | 0.1508 | 0.1508 | 0.1508 | 0.1508 | 0.1508 |
| | 250 | 0.0209 | 0.0243 | 0.0260 | 0.0269 | 0.0272 | 0.1256 | 0.1266 | 0.1293 | 0.1338 | 0.1428 |
| | 500 | 0.0189 | 0.0257 | 0.0268 | 0.0264 | 0.0265 | 0.1140 | 0.1099 | 0.1070 | 0.1091 | 0.1224 |
| | 750 | 0.0183 | 0.0264 | 0.0265 | 0.0258 | 0.0255 | 0.1010 | 0.0970 | 0.0919 | 0.0930 | 0.1049 |
| | 1,000 | 0.0184 | 0.0260 | 0.0257 | 0.0248 | 0.0243 | 0.0927 | 0.0863 | 0.0809 | 0.0814 | 0.0909 |
| | 1,500 | 0.0186 | 0.0235 | 0.0235 | 0.0222 | 0.0215 | 0.0809 | 0.0708 | 0.0656 | 0.0652 | 0.0726 |
| | 2,000 | 0.0169 | 0.0201 | 0.0206 | 0.0192 | 0.0185 | 0.0688 | 0.0589 | 0.0536 | 0.0530 | 0.0598 |
| | 2,500 | 0.0148 | 0.0163 | 0.0167 | 0.0158 | 0.0151 | 0.0552 | 0.0482 | 0.0440 | 0.0436 | 0.0474 |
| | 3,000 | 0.0129 | 0.0123 | 0.0120 | 0.0117 | 0.0114 | 0.0403 | 0.0380 | 0.0368 | 0.0356 | 0.0340 |
| 190 | 0 | 0.0237 | 0.0237 | 0.0237 | 0.0237 | 0.0237 | 0.1452 | 0.1452 | 0.1452 | 0.1452 | 0.1452 |
| | 250 | 0.0197 | 0.0215 | 0.0224 | 0.0229 | 0.0233 | 0.1254 | 0.1253 | 0.1258 | 0.1289 | 0.1324 |
| | 500 | 0.0175 | 0.0220 | 0.0228 | 0.0223 | 0.0226 | 0.1094 | 0.1052 | 0.1022 | 0.1042 | 0.1131 |
| | 750 | 0.0160 | 0.0221 | 0.0229 | 0.0216 | 0.0217 | 0.0965 | 0.0903 | 0.0854 | 0.0867 | 0.0946 |
| | 1,000 | 0.0155 | 0.0215 | 0.0221 | 0.0207 | 0.0204 | 0.0857 | 0.0794 | 0.0737 | 0.0743 | 0.0821 |
| | 1,500 | 0.0146 | 0.0191 | 0.0198 | 0.0183 | 0.0177 | 0.0714 | 0.0642 | 0.0587 | 0.0587 | 0.0662 |
| | 2,000 | 0.0122 | 0.0161 | 0.0169 | 0.0156 | 0.0148 | 0.0592 | 0.0526 | 0.0481 | 0.0479 | 0.0559 |
| | 2,500 | 0.0101 | 0.0128 | 0.0134 | 0.0125 | 0.0118 | 0.0484 | 0.0437 | 0.0400 | 0.0402 | 0.0451 |
| | 3,000 | 0.0088 | 0.0092 | 0.0092 | 0.0091 | 0.0085 | 0.0389 | 0.0355 | 0.0345 | 0.0340 | 0.0341 |
| 220 | 0 | 0.0201 | 0.0201 | 0.0201 | 0.0201 | 0.0201 | 0.1350 | 0.1350 | 0.1350 | 0.1350 | 0.1350 |
| | 250 | 0.0184 | 0.0192 | 0.0197 | 0.0196 | 0.0198 | 0.1233 | 0.1224 | 0.1256 | 0.1256 | 0.1255 |
| | 500 | 0.0167 | 0.0190 | 0.0193 | 0.0189 | 0.0191 | 0.1083 | 0.1014 | 0.0988 | 0.0988 | 0.1042 |
| | 750 | 0.0152 | 0.0190 | 0.0187 | 0.0181 | 0.0181 | 0.0913 | 0.0846 | 0.0797 | 0.0797 | 0.0889 |
| | 1,000 | 0.0138 | 0.0185 | 0.0180 | 0.0172 | 0.0170 | 0.0784 | 0.0721 | 0.0677 | 0.0677 | 0.0731 |
| | 1,500 | 0.0110 | 0.0159 | 0.0162 | 0.0150 | 0.0145 | 0.0638 | 0.0572 | 0.0524 | 0.0524 | 0.0589 |
| | 2,000 | 0.0085 | 0.0128 | 0.0137 | 0.0126 | 0.0117 | 0.0545 | 0.0477 | 0.0429 | 0.0429 | 0.0512 |
| | 2,500 | 0.0064 | 0.0096 | 0.0104 | 0.0097 | 0.0089 | 0.0469 | 0.0402 | 0.0368 | 0.0368 | 0.0430 |
| | 3,000 | 0.0053 | 0.0062 | 0.0065 | 0.0064 | 0.0059 | 0.0354 | 0.0331 | 0.0324 | 0.0324 | 0.0331 |
| 250 | 0 | 0.0170 | 0.0170 | 0.0170 | 0.0170 | 0.0170 | 0.1344 | 0.1344 | 0.1344 | 0.1344 | 0.1344 |
| | 250 | 0.0178 | 0.0160 | 0.0163 | 0.0162 | 0.0166 | 0.1226 | 0.1233 | 0.1240 | 0.1240 | 0.1183 |
| | 500 | 0.0151 | 0.0157 | 0.0160 | 0.0154 | 0.0160 | 0.1014 | 0.0997 | 0.0934 | 0.0934 | 0.0930 |
| | 750 | 0.0140 | 0.0160 | 0.0156 | 0.0146 | 0.0150 | 0.0830 | 0.0787 | 0.0733 | 0.0733 | 0.0766 |
| | 1,000 | 0.0121 | 0.0156 | 0.0149 | 0.0136 | 0.0140 | 0.0714 | 0.0660 | 0.0614 | 0.0614 | 0.0646 |
| | 1,500 | 0.0085 | 0.0131 | 0.0131 | 0.0117 | 0.0114 | 0.0573 | 0.0514 | 0.0462 | 0.0462 | 0.0514 |
| | 2,000 | 0.0055 | 0.0098 | 0.0107 | 0.0097 | 0.0087 | 0.0500 | 0.0432 | 0.0384 | 0.0384 | 0.0460 |
| | 2,500 | 0.0034 | 0.0068 | 0.0077 | 0.0072 | 0.0061 | 0.0429 | 0.0367 | 0.0334 | 0.0334 | 0.0398 |
| | 3,000 | 0.0026 | 0.0036 | 0.0042 | 0.0040 | 0.0034 | 0.0332 | 0.0306 | 0.0307 | 0.0307 | 0.0315 |

*Residual partial specific volume, cubic feet per pound.

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**The photograph was taken at a well in Dickens County, Texas,—Bond D. Jones, contractor. The reels contain 6,500 feet of UNION 7/8" Cable Tool Drilling Line, and 5,000 feet of UNION 3/4" Sand Line. The men, left to right, are: Gordon Saulsbury, driller; Don Saulsbury, tool-dresser; Leo Saulsbury, truck driver; W. B. Saulsbury, co-partner; J. W. (Red) Lawrence, co-partner; Bond D. Jones, co-partner; and J. E. Briggs, Union Wire Rope Corporation.**

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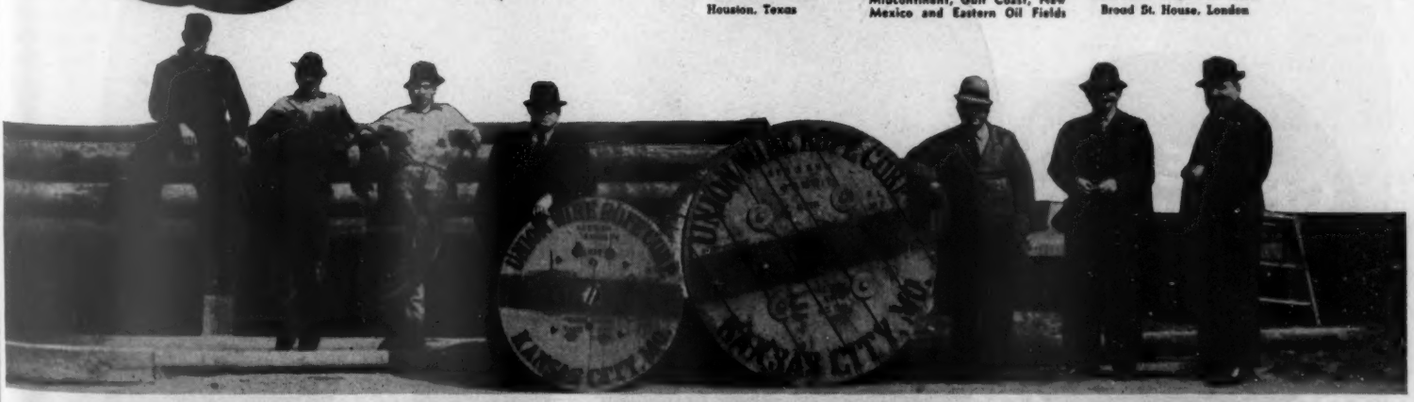

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equivalent systems of five or more components, and thus approach more nearly to the actual case.

The experimental information presented in an earlier section of this paper related to the residual partial specific volume, i. e., the residual partial volume per unit weight of component. Therefore, it is necessary to employ the weight fraction, as determined from the modified composition, rather than the mol fraction in the estimation of the specific volume of a complex gaseous mixture by the methods proposed in this paper.

The experimental information available concerning the partial volumetric behavior of methane permits the estimation of the effect of pressure, temperature, the concentration of methane and, roughly, of the nature of the other components present. It has been assumed that the residual partial specific volume of methane at a particular pressure, temperature, and weight fraction of methane is equivalent to the weighted mean of the residual partial specific volumes of methane in each of the three binary hydrocarbon systems at the same pressure, temperature, and weight fraction of methane. In obtaining this mean, the weight given to the value from a particular binary system is in direct proportion to the concentration of the heavier component of the binary system in question. On the basis of this assumption, the residual partial specific volume of methane may be established from the following expression:

$$\bar{V}_1 = \frac{(\bar{V}_1)_{1:2} n_2 + (\bar{V}_1)_{1:3} n_3 + (\bar{V}_1)_{1:4} n_4}{1 - n_1} \qquad (12)$$

It should be realized that difficulty in the direct application of Equation 12 arises when the concentration of methane in the multicomponent system is sufficiently low to permit the existence of two phases at this composition in one or more of the binary systems considered. Under these circumstances there are at least two approaches possible. The residual partial specific volume may be extrapolated from the single-phase region of the binary system in question, or the influence of these heavier components upon the partial volumetric behavior of methane may be neglected. It should be realized that the uncertainty in the estimation of the partial volumetric behavior of methane concerns only the difference between the actual behavior and the perfect gas behavior, and is not involved proportionately in the estimation of the partial volume directly.

The residual partial volumetric behavior of ethane in a complex mixture for the present must be taken as equal to that for ethane in the methane-ethane system at the same pressure, temperature, and weight fraction of ethane. This procedure assumes, in effect, that the heavier components have the same influence upon the partial specific volume of ethane as does methane. The behavior of propane and *n*-butane also may be taken to be equal to that of these components in the methane-propane and methane-*n*-butane systems, respectively.

This procedure permits the direct utilization of the tabulated residual partial specific volumes of methane, ethane, propane, and *n*-butane in the prediction of the volumetric behavior of multicomponent gaseous-hydrocarbon mixtures. If the noncondensible gases such as hydrogen, nitrogen, oxygen and, possibly, carbon dioxide are neglected insofar as deviations from the perfect gas laws are concerned, the specific volume is related to the residual partial volume in the following way:

$$V = \frac{10.732\,T}{M_a P} - \bar{V}_1 n_1 - \bar{V}_2 n_2 - \bar{V}_3 n_3 - \bar{V}_4 n_4 \qquad (13)$$

The first term of this expression would represent the specific volume of the natural gas if it followed the perfect gas laws, whereas the succeeding terms are the deviations of the partial specific volumes of each of the components from this idealized behavior. If desired, Equation 13 may be combined with Equation 12 to yield a somewhat more directly applicable relationship:

$$V = \frac{10.732\,T}{M_a P} - \left(\frac{n_1}{1-n_1}\right)\left[(\bar{V}_1)_{1:2} n_2 + (\bar{V}_1)_{1:3} n_3 + (\bar{V}_1)_{1:4} n_4\right] - \bar{V}_2 n_2 - \bar{V}_3 n_3 - \bar{V}_4 n_4 \qquad (14)$$

It is seen that Equation 14 does not involve any quantity which cannot be estimated from information recorded in Tables 1 to 3, or which is not given by the composition of the gas. In this method of correlation, because the composition exerts a direct influence upon the specific volume evaluated, any error in the analysis of the gas is reflected directly in the predicted specific volumes.

**TABLE 4—ANALYSES OF GASES**

(Expressed as mol fraction)

| Component— | Gas A[a] | Gas B* | Gas C[a] | Gas D[a] |
|---|---|---|---|---|
| Carbon dioxide | 0.000 | 0.0020 | 0.006 | ..... |
| Nitrogen and oxygen | 0.000 | 0.000 | 0.015 | ..... |
| Methane | 0.8319 | 0.8652 | 0.8778 | 0.9500 |
| Ethane | 0.0848 | 0.0575 | 0.0382 | 0.0300 |
| Propane | 0.0437 | 0.0414 | 0.0336 | 0.0200 |
| Isobutane | 0.0076 | 0.0085 | 0.0074 | .... |
| *n*-Butane | 0.0168 | 0.0161 | 0.0126 | .... |
| Isopentane | 0.0057 | 0.0083 | 0.0038 | .... |
| *n*-Pentane | 0.0032 | 0.0010 | 0.0026 | ..... |
| Hexanes | 0.0063 | ..... | 0.0030 | ..... |

*Unpublished data from A.P.I. Research Project 37

## Illustrative Applications

Experimental information concerning the volumetric behavior of multicomponent hydrocarbon gases affords a means of ascertaining the accuracy of prediction which may be made with these methods in their present incomplete state. Experimental measurements upon four different samples of natural gas here are utilized in this comparison.

**TABLE 5**

**Illustrative Calculations Utilizing Equation (14)**

Equation:

$$V = \frac{10.732\,T}{M_a P} - \left[\frac{n_1}{1-n_1}\right]\left[(\bar{V}_1)_{1:2} n_2 + (\bar{V}_1)_{1:3} n_3 + (\bar{V}_1)_{1:4} n_4\right] - \bar{V}_2 n_2 - \bar{V}_3 n_3 - \bar{V}_4 n_4$$

Gas *A* at 160 deg. F. and 2,000 lb. per sq. in., absolute

$$V = \frac{(10.732)(619.7)}{(20.43)(2{,}000)} - \left[\frac{0.6632}{0.3368}\right]\left[(0.0215)(0.1267) + (0.0158)(0.0958) + (0.0185)(0.1144)\right]$$
$$- (0.0599)(0.1267) - (0.0447)(0.0958) - (0.0589)(0.1144) = 0.1317 \text{ cu. ft. per lb.}$$

Gas *B* at 130 deg. F. and 1,000 lb. per sq. in., absolute

$$V = \frac{(10.732)(589.7)}{(19.61)(1{,}000)} - \left[\frac{0.7154}{0.2846}\right]\left[(0.0320)(0.0891) + (0.0260)(0.0941) + (0.0305)(0.1015)\right]$$
$$- (0.0823)(0.0891) - (0.0693)(0.0941) - (0.0940)(0.1015) = 0.2782 \text{ cu. ft. per lb.}$$

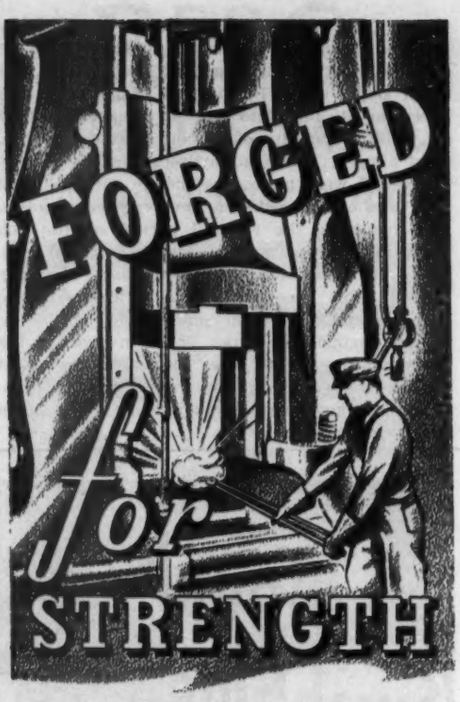
Gas *C* at 160 deg. F. and 2,000 lb. per sq. in., absolute

$$V = \frac{(10.732)(619.7)}{(19.31)(2{,}000)} - (0.9632)^{*}\left\{\left[\frac{0.7645}{0.2355}\right]\left[(0.0204)(0.0624) + (0.0174)(0.0805) + (0.0203)(0.0928)\right]\right.$$
$$\left. - (0.0634)(0.0624) - (0.0440)(0.0805) - (0.0589)(0.0928)\right\} = 0.1455 \text{ cu. ft. per lb.}$$

Gas *D* at 80 deg. F. and 2,000 lb. per sq. in., absolute

$$V = \frac{(10.732)(539.7)}{(17.02)(2{,}000)} - \left[\frac{0.895}{0.105}\right]\left[(0.0313)(0.053) + (0.030)(0.052)\right]$$
$$- (0.0835)(0.053) - (0.060)(0.052) = 0.1352 \text{ cu. ft. per lb.}$$

*Total weight fraction of hydrocarbons. In this case all *n*-values in the equation are based upon hydrocarbons only.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The analyses of these gases are given in Table 4. Table 5 presents an illustrative numerical example of the application of Equation 14 for each gas at a single state. In the case of gas C it was necessary to take into account the presence of a significant quantity of carbon dioxide, nitrogen, and oxygen. These nonhydrocarbon components of gas C were treated as though they followed the laws of ideal solution and were perfect gases. In computing the residual partial specific volumes of the hydrocarbon components, the presence of these nonhydrocarbon gases was neglected. This necessitated a modification of the residual specific volume computed for the hydrocarbon components which is not involved in the computations for the other gases. This treatment of nonhydrocarbon gases is arbitrary, but probably does not introduce significant uncertainties as long as the gases involved do not contain large quantities of these components. The calculation represented by Equation 14 is somewhat longer than would be desired. However, it is believed that it represents as great a simplification of a complex problem as could be made without introducing uncertainties of engineering significance, even though a much more complete experimental background were employed than is at present available.

Table 6 offers a comparison of the experimental and calculated specific volumes of the four gases employed. In all cases the calculated values are somewhat lower than the experimentally measured specific volumes at the highest pressures recorded. This probably results from the use of the residual partial specific volume of *n*-butane to represent the partial volumetric behavior of the heavier components. At the higher pressures there appears to be a tendency for the residual partial specific volumes of the hydrocarbon components to decrease with an increase in molecular weight, whereas the reverse tendency exists at the lower pressures. These trends would indicate that the predictions of specific volume would be too large at the low pressures, and too small at the higher pressures, as a result of the use of the values of *n*-butane as representative of the heavier components. These trends correspond in general with the discrepancies given in Table 6.

In all cases except for gas C, the agreement is considered satisfactory at pressures up to 2,000 lb. per sq. in. Deviations as large as 2.9 per cent are involved at the lower pressures for gas C. The experimental method used to determine the specific volume of this gas was such that uncertainities in the analysis would tend to cause more important discrepancies between experimental and predicted values. This case was complicated also by the presence of significant quantities of nonhydrocarbon gases.

The rapidly increasing uncertainty involved in the predictions at pressures above 2,000 lb. per sq. in. indicates that more detailed information than at present is available will be necessary in order to predict volumetric behavior with accuracy in this region. However, it is believed that the agreement, even on the present basis, is sufficiently good in most cases that the method of prediction may be of engineering value. As more information accumulates, it will be possible to take into account pertinent factors which were omitted in this tentative approach. The method is such that it permits the utilization of new information as it becomes available.

**TABLE 6—COMPARISON OF EXPERIMENTAL AND CALCULATED SPECIFIC VOLUMES**

| Temperature (°F.) | Pressure (lb. per sq. in.) | Specific volume (cu. ft. per lb.) Experimental | Calculated | Error per cent |
|---|---|---|---|---|
| | | **Gas A** | | |
| 100 | 500 | 0.5300[21] | 0.5335 | +0.7 |
| | 1,000 | 0.2412 | 0.2414 | +0.1 |
| | 2,000 | 0.1064 | 0.1065 | +0.1 |
| | 3,000 | 0.0736 | 0.700 | −4.9 |
| 160 | 500 | 0.6063 | 0.6037 | −0.4 |
| | 1,000 | 0.2856 | 0.2843 | −0.5 |
| | 2,000 | 0.1326 | 0.1317 | −0.7 |
| | 3,000 | 0.0892 | 0.0872 | −2.2 |
| 220 | 500 | 0.6803 | 0.6742 | −0.9 |
| | 1,000 | 0.3282 | 0.3232 | −1.5 |
| | 2,000 | 0.1569 | 0.1547 | −1.4 |
| | 3,000 | 0.1051 | 0.1026 | −2.4 |
| | | **Gas B** | | |
| 70 | 500 | *0.5145 | 0.5181 | +0.7 |
| | 1,000 | 0.2292 | 0.2329 | +1.6 |
| 130 | 500 | 0.5960 | 0.5960 | 0.0 |
| | 1,000 | 0.2779 | 0.2782 | +0.1 |
| | | **Gas C** | | |
| 160 | 500 | 0.6355[20] | 0.6482 | +2.0 |
| | 1,000 | 0.3045 | 0.3083 | +1.2 |
| | 2,000 | 0.1480 | 0.1454 | −1.8 |
| | 3,000 | 0.1022 | 0.0973 | −4.7 |
| 220 | 500 | 0.7004 | 0.7206 | +2.9 |
| | 1,000 | 0.3453 | 0.3489 | +1.0 |
| | 2,000 | 0.1663 | 0.1682 | +1.1 |
| | 3,000 | 0.1120 | 0.1091 | −2.6 |
| | | **Gas D** | | |
| 80 | 500 | 0.6260[23] | 0.6325 | +1.0 |
| | 1,000 | 0.2919 | 0.2962 | +1.5 |
| | 2,000 | 0.1340 | 0.1351 | +0.8 |
| | 3,000 | 0.0907 | 0.0902 | −0.6 |

*Unpublished data from A.P.I. Research Project 37

## Summary

A method has been proposed for the prediction of the specific volume of complex gaseous-hydrocarbon mixtures. The procedure to be followed in using this method may be summarized in the following steps:

1. The analysis of the gas, which commonly is expressed as the mol fraction of each of the components present, first is modified to yield a corresponding quaternary analysis by application of Equations 10 or 11.

2. The corresponding quaternary analysis is re-expressed in terms of weight fractions instead of mol fractions.

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3. The residual partial specific volumes of methane, ethane, propane, and *n*-butane for the prevailing pressure, temperature, and weight fraction of the component in question are interpolated from the information recorded in Tables 1 to 4, inclusive. In general, simple linear interpolation with respect to pressure, temperature, and composition is adequate for this purpose. The value used for methane is taken as a weighted mean of the values obtained for the binary systems involving methane with each of the other components of the modified analysis in accordance with Equation 12.

4. The average molal weight $M_a$ of the gas is computed from the original analysis.

5. The specific volume is calculated directly by substitution of the appropriate values in Equation 14.

## Acknowledgments

The work reported was carried out as a part of the activities of Research Project 37 of the American Petroleum Institute, to which the authors are grateful for financial support and cooperation. Louise M. Reaney and L. Fay Prescott assisted with the numerical calculations involved in the preparation of the correlation.

## Nomenclature

| | |
|---|---|
| b | Specific gas constant; $\frac{R}{M} = \frac{10.732}{M}$ (lb. per sq. in.) (cu. ft. per lb.) per deg. F., absolute. |
| M | Molal weight, pounds. |
| $M_a$ | Average molal weight, obtained from actual analysis, pounds. |
| $m_k$ | Weight of component $k$, pounds. |
| $\underline{n}$ | Mole fraction. |
| $\underline{n}'$ | Modified mole fraction. |
| n | Weight fraction in modified analysis. |
| P | Pressure, pounds per square inch, absolute. |
| T | Temperature, deg. F., absolute. |
| $\underline{V}$ | Total volume of system, cubic feet. |
| $\overline{V}$ | Specific volume, cubic feet per pound. |
| $V_R$ | Reference specific volume, cubic feet per pound. |
| $\underline{\mathrm{V}}$ | Residual specific volume, cubic feet per pound. |
| $\overline{\mathrm{V}}$ | Partial specific volume, cubic feet per pound. |
| $\overline{\mathrm{V}}$ | Residual partial specific volume, cubic feet per pound. |
| $(\overline{\mathrm{V}}_1)_{1,2}$ | Residual partial specific volume of methane in the methane-ethane system, cubic feet per pound. |

| | |
|---|---|
| Subscripts 1, 2, 3, 4 | refer to methane, ethane, propane, and *n*butane, respectively. |
| Subscript n | refers to component *n* in an *n*-component system. |
| Subscript k | refers to any component *k*. |
| Subscript i | refers to all components except component *k*. |

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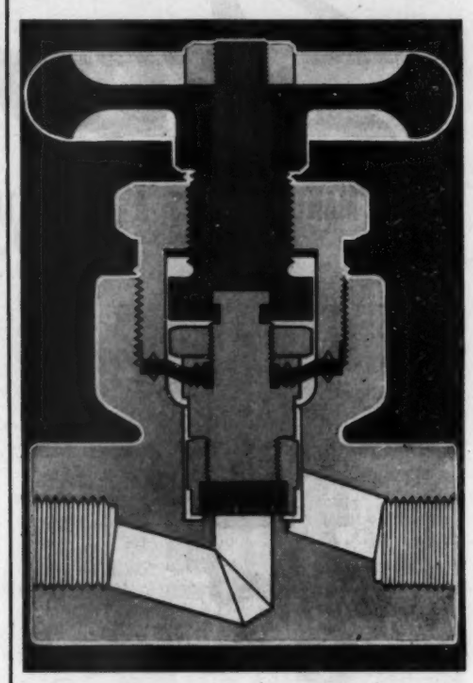

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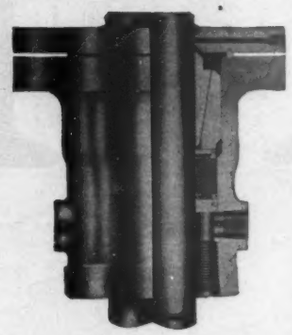

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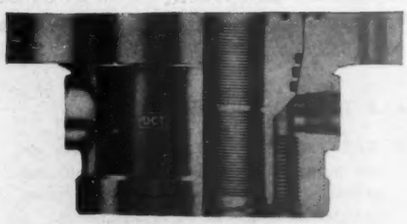

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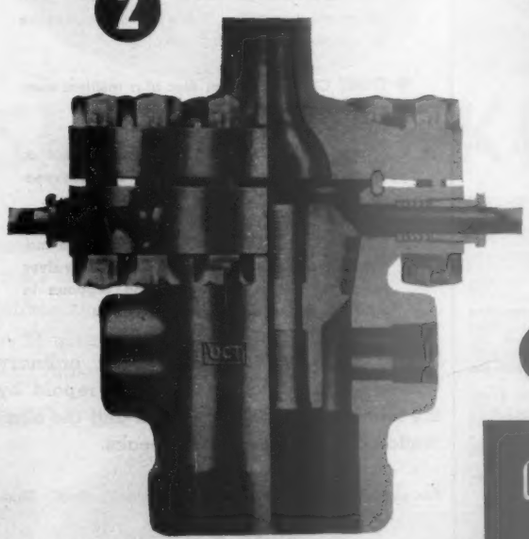

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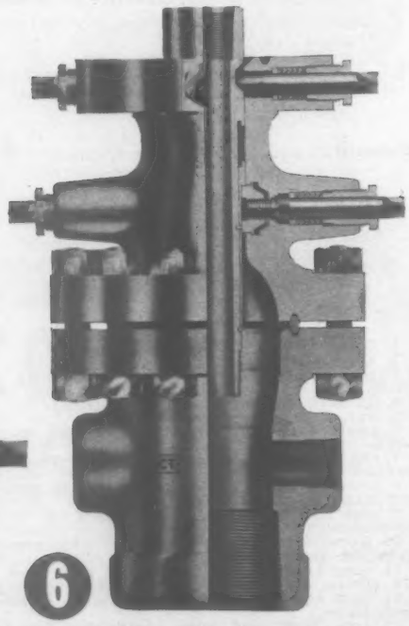

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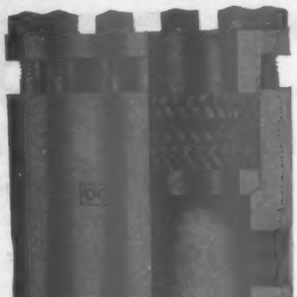

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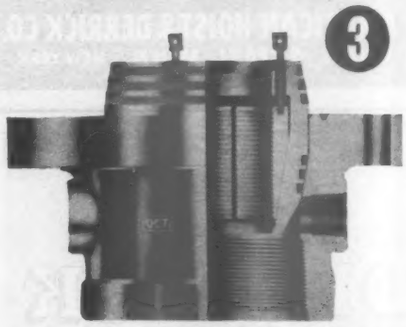

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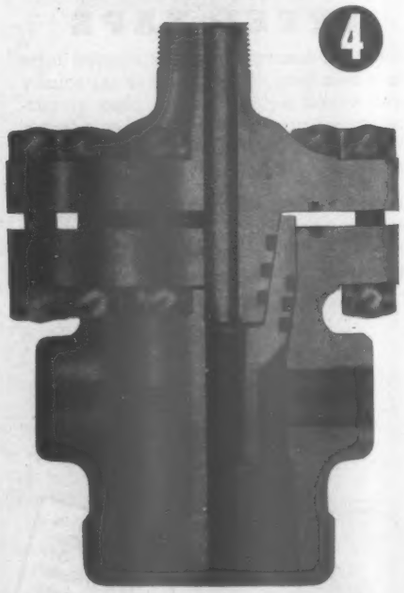

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# Catalytic Desulfurization to Improve Aviation Blending Naphthas


## SUMMARY

**Experimental investigation has shown that the tetraethyl lead response of aviation gasolines consisting of blends of isooctane base and straight-run naphtha either of refinery or natural gasoline origin may be markedly improved by removal of the sulfur compounds from the naphtha. Practically complete desulfurization has been obtained by treatment of the naphtha vapors over bauxite catalyst at temeratures of 700° to 750° F.**

**Since the desulfurized blends have greater lead response, the minimum percentage of isooctane required in high-octane gasoline may be appreciably reduced. It is possible, therefore, to increase the production of high-octane gasoline without a corresponding increase in isooctane base. If desired, the hydrocarbon composition of the blend may be left unchanged and a higher-octane gasoline be produced as a result of the improved lead response.**

**In the case of Hobbs pentane-free natural gasoline the production of high-octane blended and ethylized aviation gasoline for a given amount of isooctane was increased as follows:**

**92-octane number with 0.5 cc. TEL—19.7 per cent**
**100-octane number with 3.0 cc. TEL—27.7 per cent**
**87-octane number with 1.0 cc. TEL—52.2 per cent**



**By W. A. SCHULZE and R. C. ALDEN**
Phillips Petroleum Co.


SOME very notable advances have been made in aviation gasoline within the last few years, the greatest single improvement having come with the manufacture of isooctane on a commercial scale. In service these high-octane-number gasolines have shown such marked superiority over the lower-octane fuels that a great deal of emphasis is being placed today on means of still further improvement.

Since isooctane does not possess the proper vapor pressure or distillation characteristics of a finished gasoline, it must be considered merely as a blending stock. This means, of course, that attention must be focused on the naphthas which are blended with the isooctane. For example, in the manufacture of 100-octane ethylized gasoline it is common practice for the finished blend to contain from 35 to 60 per cent commercial isooctane, the remainder being refinery straightrun gasoline. In some instances, however, as much as 25 per cent of isopentane is used, the aviation blending naphtha in such cases usually being depentanized or fractionated to a comparatively high initial boiling point. The straightrun gasolines may range from selected natural gasolines to high-octane-number naphthas of relatively high boiling points. In most instances the maximum permissible tetraethyl lead (TEL) is 3.0 cc per gallon although still higher maxima are sometimes permitted. To simplify the present discussion the maximum TEL content of 3.0 cc. has been selected.

In the manufacture of aviation gasolines of less than 100-octane number, the antiknock characteristics of the blending naphthas are likewise of importance. Two typical examples have been selected for this study, namely (1) 92-octane-number gasoline with a maximum of 0.5 cc. TEL per gallon and (2) 87-octane-number gasoline with a maximum of 1.0 cc. per gallon. In both instances it has been assumed that commercial isooctane and isopentane would be blended with a straight-run or natural gasoline.

### Effect of Sulfur on Lead Response

Schulze and Buell in an article published in 1935 showed how sulfur compounds present in motor fuels affected the lead responsiveness of such fuels.[1] Other workers have confirmed these results.[2,3] Of the various classes of sulfur compounds in petroleum oils, the most common are hydrogen sulfide, elementary sulfur, mercaptans, aliphatic and aromatic monosulfides and disulfides, and cyclic-sulfur compounds such as the thiophenes and the "thiophanes." Occasionally there may also be found alkyl polysulfides, resulting from certain sweetening processes, and sometimes there may be traces of sulfones and sulfoxides. Since chemical treatment is usually employed to remove the corrosive compounds and the mercaptans are converted to disulfides in some sort of sweetening process, we are interested primarily in the effects produced by the monosulfides, disulfides and cyclic-sulfur compounds. Fig. 1a, reproduced from the previously mentioned paper,[1] shows the behavior of certain members of each of these classes of sulfur compounds. It should be especially noted that the deleterious effect of sulfur is greatest at low concentrations; this means that the removal of even small amounts of sulfur from the aviation blending stocks will produce sizable increases in lead response.

### Catalytic Desulfurization of Components of 100-Octane Gasoline

Most of the commercial isooctane produced has a very low-sulfur content because the methods of manufacture include desulfurization of the feed stocks. Therefore, improvement in the TEL response of the commercial isooctane, if needed, is attained by methods other than those here proposed. Isopentane is produced practically free of sulfur and in addition has a tremendous susceptibility to TEL. Consequently, improvement in lead response by reduction of the sulfur content is largely limited to the aviation naphthas used in blending. It is on these latter stocks that catalytic desulfurization shows such excellent results.

In the catalytic treatment the hydrocarbon vapors are contacted at temperatures in the range of 700° to 750° F. with bauxite catalyst, whereby the sulfur compounds are decomposed into hydrogen sulfide. Since complete removal of mercaptans, monosulfides and disulfides can be obtained in this manner, and since very little or no cyclic sulfur is present in these low-boiling gasolines, it is possible to produce practically sulfur-free stocks.

Numerous natural gasolines and straightrun naphthas have been subjected to appraisal. To indicate the results obtainable, data on four stocks are herewith presented. The characteristics of the four stocks are briefly summarized in the following tabulation:

| Description— | Borger "butane-free" natural gasoline | Borger "pentane-free" natural gasoline | Hobbs "Pentane-free" natural gasoline | New Mexico straight-run gasoline |
|---|---|---|---|---|
| Reid vapor pres. . . | 12.0 | 6.4 | 5.2 | 11.2 |
| A.S.T.M. distillation: | | | | |
| 10% evap. (°F.) | 103 | 142 | 161 | 121 |
| 50% evap. (°F.) | 122 | 164 | 174 | 150 |
| 90% evap. (°F.) | 201 | 226 | 229 | 180 |
| Per cent sulfur . | 0.037 | 0.057 | 0.096 | 0.013 |
| Unleaded Oct. No. | 67.2 | 59.2 | 65.6 | 76.0 |

The above stocks were selected as examples to cover high, medium, and low-sulfur contents and to include a wide range of octane numbers of untreated gasolines. In general, the boiling range of the gasoline has no relationship to the improvements in lead susceptibility as attained by bauxite desulfurization.

Table 1 gives the octane number and lead response data on Borger 12-lb. natural gasoline desulfurized to different levels.

It should be noted that there is a very appreciable difference in lead response between the gasolines of 0.008 and 0.004 per cent sulfur content. A definite but smaller improvement is ap-


***A.P.I.*** **— Presented before annual meeting, Chicago, Ill., November 13-17, 1939**


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parent in further reducing the sulfur to 0.002 per cent. A similar effect on the original octane numbers may be noted. This wide difference in lead response between gasolines with only a few thousandths per cent difference in sulfur content as the sulfur content approaches zero is greater than most people have suspected. The increasing difference as greater amounts of lead are added is especially significant with respect to aviation fuels. A graphical representation of these effects is given in Fig. 1.

**TABLE 1—AVERAGE TEL REQUIREMENTS OF BORGER 12-LB. NATURAL**

| | Undesulfurized | Desulfurized | | |
|---|---|---|---|---|
| Per cent sulfur | 0.037 | 0.008 | 0.004 | 0.002 |
| Average Oct. No., A.S.T.M.: | | | | |
| Initial | 67.2 | 69.5 | 69.6 | 69.7 |
| +½ cc. TEL | 72.2 | 76.5 | 76.8 | 77.0 |
| +1 cc. TEL | 75.6 | 80.0 | 81.0 | 81.4 |
| +2 cc. TEL | 79.6 | 82.0 | 84.3 | 84.9 |
| +3 cc. TEL | 82.1 | 85.3 | 86.8 | 87.5 |
| +4 cc. TEL | 84.0 | 87.6 | 89.2 | 89.7 |
| +6 cc. TEL | 86.6 | 91.2 | 92.8 | 93.2 |
| TEL saving to 76-octane number, per cent | ... | 58 | 60 | 62 |
| TEL saving to 82-octane number, per cent | ... | 46 | 57 | 62 |
| TEL saving to 88-octane number, per cent | ... | 43 | 52 | 56 |

Since a mixture of isopentane and pentane-free natural gasoline is superior to 12-lb. natural for blending with isooctane, some representative data are presented on the catalytic desulfurization of so-called "pentane-free" naturals. Table 2 gives the inspection data on the Borger gasoline before and after the bauxite treatment while Fig. 2 shows the TEL curves. The treated product with 1 cc. TEL rates 8.1-octane numbers higher than the untreated; with 3 cc. TEL the improvement is 7.7-octane numbers. It should be noted that the desulfurized gasoline with 1 cc. TEL has a rating of 75.0 octane whereas the undesulfurized gasoline with 3 cc. TEL rates only 74.3. In the treatment the sulfur content was lowered from 0.057 to 0.005 per cent, a reduction of 91 per cent. The distillation and vapor pressure characteristics were unchanged.

It may appear surprising at first thought that a naphtha of only 60-octane number should be considered a suitable blending stock in the manufacture of high-octane-number gasolines. However, a closer study of the data presented will reveal the fact that these pentane-free natural gasolines have extremely good TEL susceptibilities so that

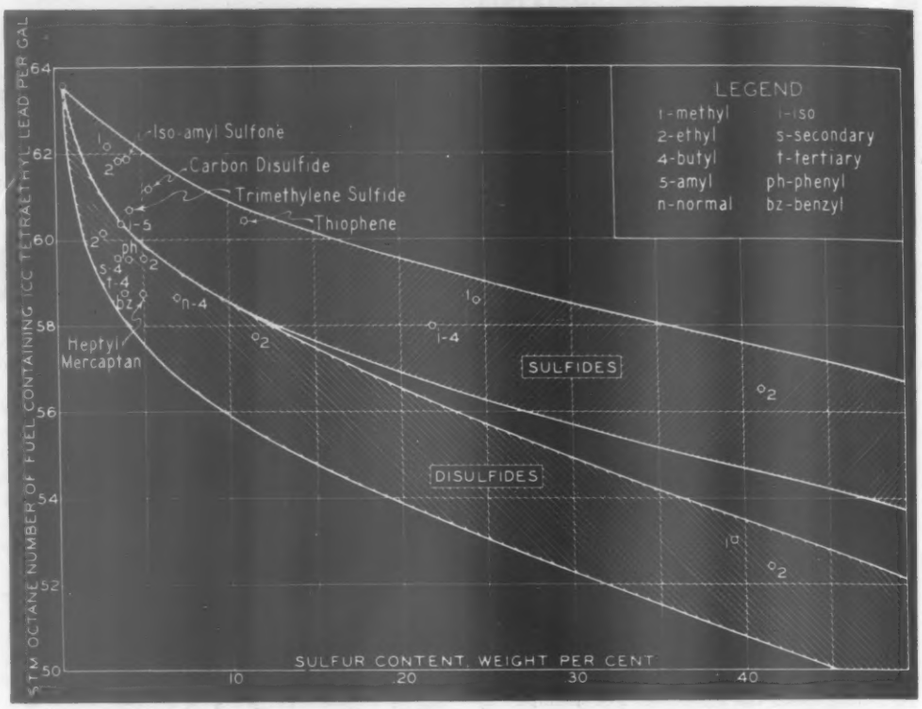


*Fig. 1a—Effect of various sulfur compounds on lead susceptibility of reference fuel*


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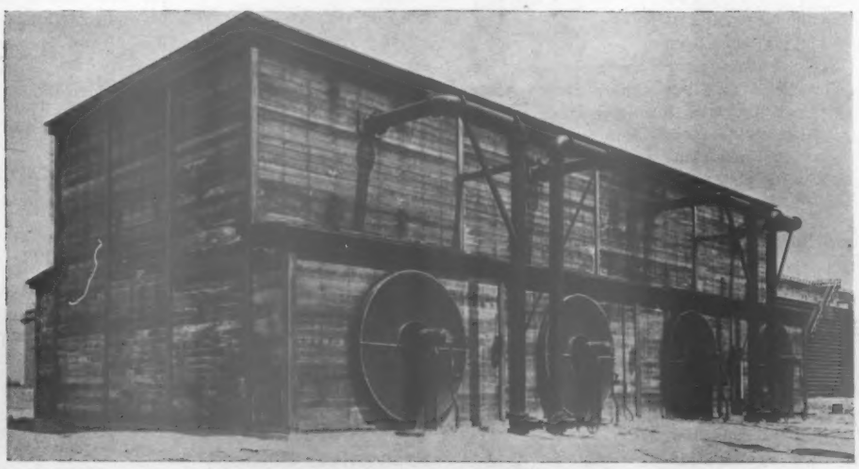

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in the manufacture of ethylized gasolines they are equal and in some cases superior to other naphthas of considerably higher clear-octane numbers.

**TABLE 2—DESULFURIZATION OF BORGER PENTANE-FREE NATURAL GASOLINE**

| A.S.T.M. octane number: | Before desulfurizing | After desulfurizing |
|---|---|---|
| 0 cc. TEL per gallon | 59.2 | 61.1 |
| +0.5 cc. TEL per gallon | 63.5 | 68.9 |
| +1.0 cc. TEL per gallon | 66.9 | 75.0 |
| +2.0 cc. TEL per gallon | 71.6 | 79.8 |
| +3.0 cc. TEL per gallon | 74.3 | 82.0 |
| TEL to 76 octane, cc./gal. | 3.90 | 1.12 |
| Saving per gallon, cc. | ... | 2.78 |
| Sulfur, per cent | 0.057 | 0.005 |
| Reid vapor pressure | 6.40 | 6.50 |
| Gravity, °A.P.I. | 71.2 | 71.9 |
| Distillation: | | |
| First drop, °F. | 121 | 120 |
| 5 per cent evap., °F. | 137 | 138 |
| 10 | 142 | 143 |
| 20 | 147 | 148 |
| 30 | 152 | 153 |
| 40 | 157 | 158 |
| 50 | 164 | 164 |
| 60 | 172 | 173 |
| 70 | 182 | 183 |
| 80 | 198 | 200 |
| 90 | 226 | 228 |
| 95 | 263 | 265 |
| End point | 380 | 384 |
| Recovery, per cent | 98.2 | 98.2 |
| Residue, per cent | 1.0 | 1.0 |
| Evap. at 212° F., per cent | 85.5 | 85.0 |

The pentane-free natural gasoline from Hobbs, New Mexico, had a considerably higher sulfur content and a higher clear-octane number than the corresponding stock from Borger. The higher octane number would seem to be an added advantage for aviation-gasoline blending but this

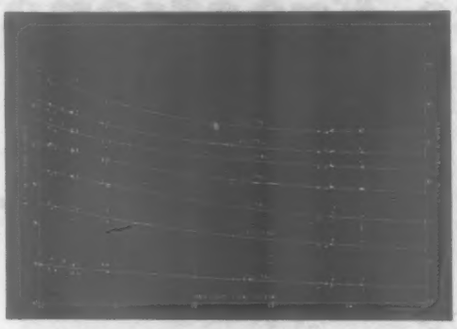


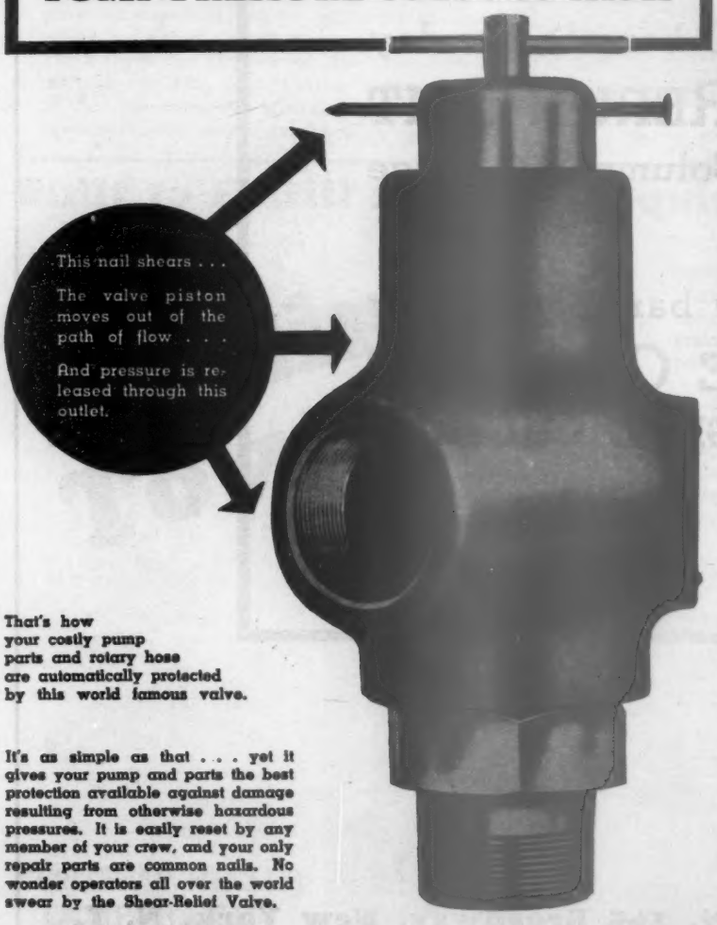
*Fig. 1—Effect of sulfur content on TEL response of 12-lb. Borger natural gasoline*

is offset by the poor lead response. The undesirable sulfur compounds may be removed, however, by the bauxite treatment mentioned above. Table 3 shows the inspection tests on this gasoline before and after treatment at a temperature of 750° F. and at a flow rate equivalent to 325 bbl. of gasoline per day per ton of bauxite catalyst. The sulfur content was reduced from 0.096 to 0.008 per cent.

**TABLE 3—HOBBS PENTANE-FREE NATURAL GASOLINE**

| A.S.T.M. octane number: | Before desulfurizing | After desulfurizing | Improvement |
|---|---|---|---|
| 0 cc. TEL per gallon | 65.6 | 65.6 | 0.0 |
| 1 cc. TEL per gallon | 71.4 | 77.7 | 6.3 |
| 2 cc. TEL per gallon | 76.0 | 82.3 | 6.3 |
| L-3 octane number: | | | |
| 0 cc. TEL per gallon | 64.2 | 64.2 | 0.0 |
| 1 cc. TEL per gallon | 71.6 | 78.4 | 6.8 |
| 2 cc. TEL per gallon | 76.6 | 83.9 | 7.3 |
| Reid vapor pressure | 5.20 | 5.20 | ... |
| Gravity, °A.P.I. | 68.6 | 68.5 | ... |
| Distillation: | | | |
| First drop, °F. | 145 | 141 | ... |
| 5 per cent evap., °F. | 155 | 153 | ... |
| 10 | 161 | 157 | ... |
| 20 | 164 | 161 | ... |
| 30 | 166 | 166 | ... |
| 40 | 169 | 169 | ... |
| 50 | 174 | 173 | ... |
| 60 | 179 | 178 | ... |
| 70 | 189 | 188 | ... |
| 80 | 203 | 203 | ... |
| 90 | 229 | 227 | ... |
| 95 | 256 | 252 | ... |
| End point | 314 | 311 | ... |
| Recovery, per cent | 98.7 | 98.8 | ... |
| Residue, per cent | 0.8 | 0.8 | ... |
| Loss, per cent | 0.5 | 0.4 | ... |
| Per cent at 212° F. | 85.0 | 84.5 | ... |


LOOK WHAT HAPPENS WHEN PUMP PRESSURE GOES TOO HIGH

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The data presented in Tables 4 and 5 are illustrative of the effect of catalytic desulfurization when applied to a light straightrun gasoline previously given extensive chemical treatment and fractionation. This gasoline, obtained from New Mexico crude, had only 0.013 per cent sulfur left in it at the time the catalytic treatment was made. Obviously, catalytic desulfurization would not be applied at this point in the processing, but the results do show the increased benefits to be derived from complete desulfurization. As is usual for low-sulfur straightrun gasolines, there

*Fig. 2—Six-pound Borger natural gasoline before and after desulfurization*

was no change in the initial octane number of the gasoline on the catalytic treatment. However, upon the addition of 1 cc. of tetraethyl lead per gallon, the desulfurized gasoline showed a response of 10.9 octane numbers while the undesulfurized had a response of only 9.0 units. Although the improvement is not large in terms of octane numbers, the percentage of isooctane in 100-octane fuel can be decreased through the use of the more completely desulfurized straightrun naphtha.

**TABLE 4—NEW MEXICO LIGHT STRAIGHTRUN GASOLINE**

| A.S.T.M. octane number: | Before catalytic desulfurization | After catalytic desulfurization |
|---|---|---|
| 0 cc. TEL per gallon | 76.0 | 76.0 |
| 1 cc. TEL per gallon | 85.0 | 86.9 |
| 2 cc. TEL per gallon | 88.7 | 90.0 |
| 3 cc. TEL per gallon | 91.2 | 92.2 |
| Reid vapor pressure | 11.2 | 11.25 |
| Gravity, °A.P.I. | 76.1 | 76.2 |
| Color | +30+ | +30+ |
| Distillation: | | |
| First drop, °F. | 98 | 95 |
| 5 per cent evap., °F. | 112 | 113 |
| 10 | 121 | 119 |
| 20 | 129 | 128 |
| 30 | 137 | 136 |
| 40 | 143 | 143 |
| 50 | 150 | 150 |
| 60 | 157 | 156 |
| 70 | 163 | 163 |
| 80 | 170 | 169 |
| 90 | 180 | 180 |
| 95 | 190 | 191 |
| End point | 204 | 206 |
| Recovery, per cent | 98.1 | 98.8 |
| Residue, per cent | 0.3 | 0.4 |
| Loss, per cent | 1.6 | 0.8 |

**TABLE 5—NEW MEXICO LIGHT STRAIGHTRUN GASOLINE**

| | Before catalytic desulfurization | After catalytic desulfurization |
|---|---|---|
| Color Saybolt | +30+ | +30+ |
| Doctor test | Negative | Negative |
| Sulfur, per cent | 0.013 | 0.0016 |
| Copper strip, 122° F. | 5 hrs.+ | 5 hrs.+ |
| Copper dish gum, mg/100 cc. | 1 | 2 |
| A.S.T.M. gum, mg/100 cc. | 0 | 0 |
| Oxygen bomb, stability, min. | 300+ | 300+ |
| Acid heat, °F. | 4 | 4 |

## Blends of Isooctane With Undesulfurized and Desulfurized Naphthas

The increase in lead response of blends of isooctane with catalytically desulfurized naphtha is nearly always directly proportional to the amount of such naphtha in the blends, the effect being undiminished on mixing with other products. Thus, the monetary savings to be derived through catalytic desulfurization of the blending naphtha may come about in two ways; namely, (1) the increase in production of a given grade of aviation gasoline from a given volume of isooctane, and (2) increased octane numbers obtainable with given blending formulas and TEL contents. Since the increased production of given grades of high-octane gasoline constitutes a tangible and important basis for appraising the benefits to be derived from the catalytic desulfurization, data are presented below for three of the four gasolines previously discussed. The Borger 12-lb. gasoline obviously has an octane number-vapor pressure relationship inferior to the other three gasolines.

For the isooctane blending experiments described in the following paragraphs the commercial isooctane used was one with 91-octane number and a very superior lead response. All blends were isopentanized (about 20 per cent usually) to 7.0-lb. vapor pressure.

*Borger "pentane-free" natural gasoline.*—To determine the effect of partial desulfurization this material was desulfurized to varying degrees with the following results expressed in terms of the increase in production of 100-octane gasoline with 3.0 cc. TEL.

| Sulfur content "pentane-free" natural | Per cent isooctane required | Per cent increased production of 100-octane number gasoline |
|---|---|---|
| 0.056% (undesulfurized) | 66.0 | ... |
| 0.017% (undesulfurized) | 58.5 | 12.8 |
| 0.013% (undesulfurized) | 55.2 | 19.6 |


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| Greenlee Foundry Company | Chicago, Ill. | Florence Pipe Foundry & Machine Co. (R. D. Wood Company, Selling Agents) | Philadelphia, Pa. |
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| Kinney Iron Works | Los Angeles, Calif. | | |

With further desulfurization, for example to the 0.005 shown in Table 2, the increased production of 100-octane gasoline would, of course, be much greater than the above figures.

*Hobbs "pentane-free" natural gasoline.*—Because of the favorable antiknock characteristics of this aviation natural gasoline, extensive blending experiments were conducted with isooctane. A comparison of the blending values of the pentane-free natural gasoline before and after desulfurization is shown in Fig. 3, wherein the per cent of isooctane base is plotted against the octane number. As previously mentioned all of the blends contained sufficient isopentane to give 7.0 lb. Reid vapor pressure.

From the data on which Fig. 3 was derived the calculations shown in the following tabulation have been made.

| Kind of finished gasoline | | Per cent isooctane in finished gasoline containing | | Per cent increase in production by desulfurization |
|---|---|---|---|---|
| Oct. No. | Cc. TEL | Undesulfurized P.F. natural | Desulfurized P.F. natural | |
| 92 | 0.5 | 70.0 | 58.5 | 19.7 |
| 100 | 3.0 | 89.2 | 54.2 | 27.7 |
| 87 | 1.0 | 44.6 | 29.3 | 52.2 |

In addition to the decrease of isooctane there were also smaller decreases in the isopentane used in the blends with desulfurized gasolines. If the refiner does not use isopentane in the aviation blends, the increase in finished gasoline production is even greater than shown above.

With given blending formulas and TEL contents within the range indicated, the following increases in octane number are obtainable through desulfurization of the pentane-free natural used in the blends:

| Cc. TEL | Increase in octane number |
|---|---|
| 0.5 | 3.0 |
| 1.0 | 4.0 |
| 1.5 | 4.3 |
| 2.0 | 4.7 |
| 3.0 | 5.3 |

Thus, the octane number of the finished gasoline was increased as much as five units merely through desulfurization of the naphtha. Such a sizable improvement in this high-octane-number bracket obviously warrants considerable attention.

*New Mexico straightrun gasoline.*—In 7.0-lb. isooctane blends of the New Mexico straightrun gasoline before and after desulfurization, the TEL requirement to 100-octane number was 3.4 cc. for the former and 2.7 cc. for the latter.

From the test data it is estimated that the per cent isooctane required to just make 100-octane

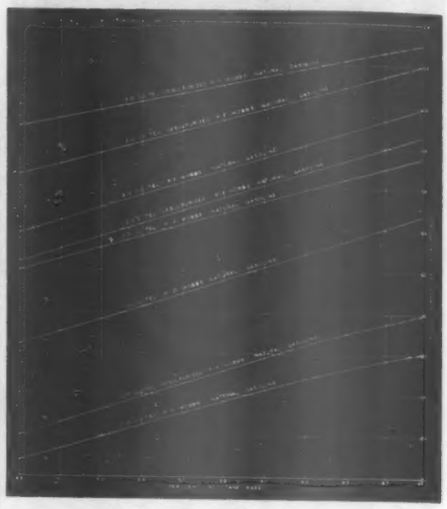


*Fig. 3—Comparison of the blending value of undesulfurized and desulfurized pentane-free Hobbs natural gasoline in the manufacture of aviation gasoline*

number with 3.0 cc. TEL was changed from 56.0 to 48.8 by desulfurization of the New Mexico straightrun gasoline. This represents an increase in 100-octane-gasoline production of 14.8 per cent.

It should be recalled that the New Mexico straightrun gasoline had the very low sulfur content of 0.013 before the bauxite desulfurization treatment. This example, therefore, illustrates the advantages to be derived from complete desulfurization.

## Conclusions

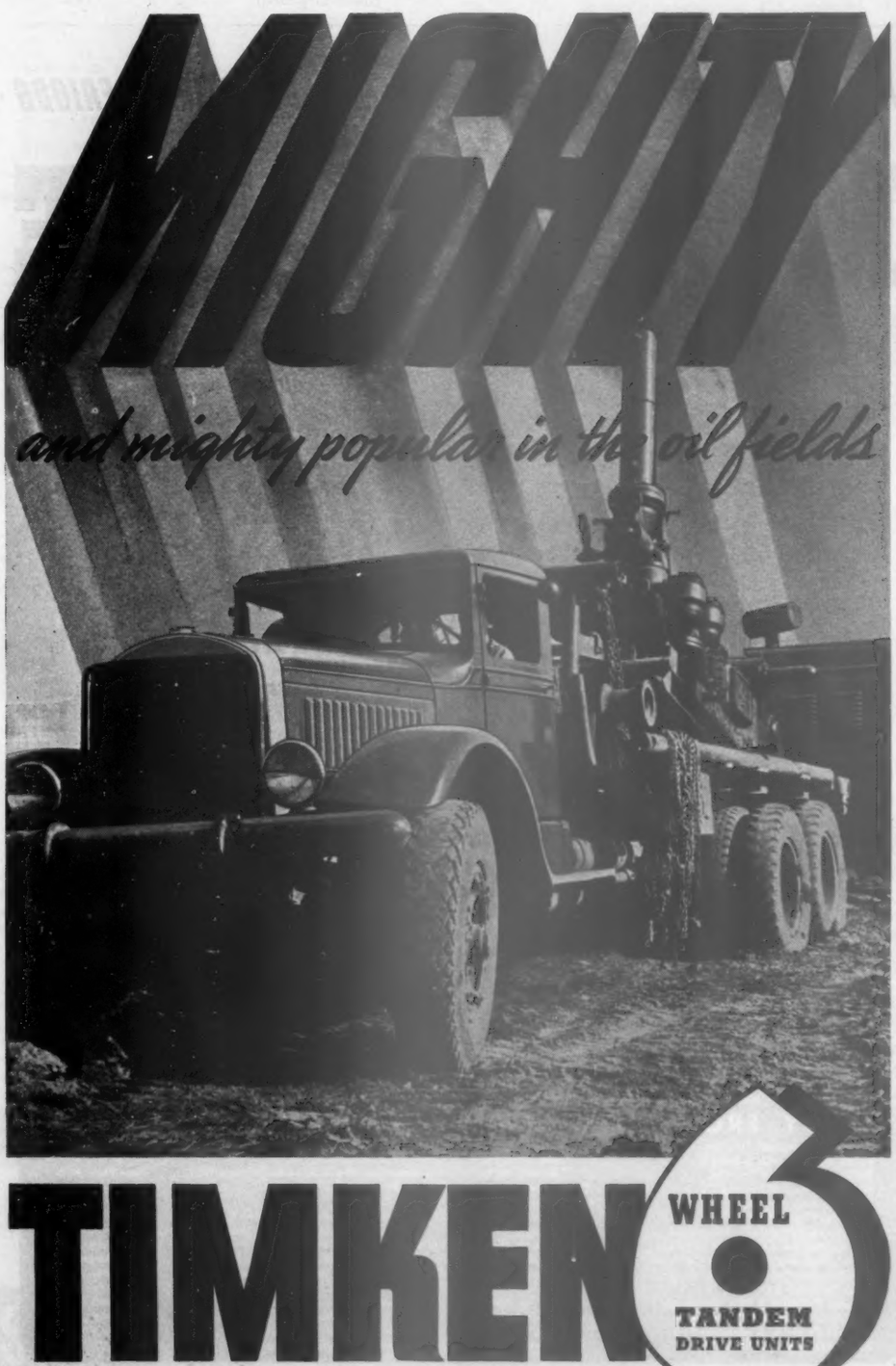
The catalytic removal of sulfur from aviation blending naphthas even when the sulfur content is originally very low has been shown to exert a beneficial effect on TEL susceptibility. In the case of one blending naphtha, a pentane-free natural gasoline of high sulfur content and comparatively high octane number, catalytic desulfurization increased the amount of finished gasoline that could be made from a given quantity of 91-octane commercial isooctane by the following percentages:

92 octane with 0.5 cc. TEL—19.7 per cent.
100 octane with 3.0 cc. TEL—27.7 per cent.
87 octane with 1.0 cc. TEL—52.2 per cent.

## Dismissal of Detroit Suit Denied by U. S. Court

DETROIT, Mich.—Six oil companies named in a $2,700,000 damage suit brought by Charles E. Austin, Inc., oil station operator, were denied dismissal of the suit by federal Judge Frank A. Picard. The court directed the plaintiff file an amended bill of particulars to give fuller details.

The defendants are Sun Oil Co., Hickok Oil Corp., Socony-Vacuum, Pure Oil, Shell, and Puritian Stations, Inc. Mr. Austin charges they conspired to ruin his business and violated the antitrust law.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# Internal Corrosion

## . . . of Gasoline Pipe Lines

By L. C. MORRIS and W. A. SCHULZE
Phillips Petroleum Co.

**A. P. I. — Presented before annual meeting, Chicago, Ill., November 13-17, 1939**

WHEN long-distance transportation of gasoline by pipe line was begun on a large scale some years ago, much thought was given to minimizing the effect on the properties of the gasoline while little or no attention was directed to the effect of the gasoline on the pipe line. External corrosion similar to that experienced with crude oil lines was expected and various means were taken to protect the exterior side of the pipe. A new problem soon arose, however, in that under certain conditions severe corrosion was encountered on the interior side of the pipe. Since the capital investment in such a modern gasoline transportation system is large, considerable effort has been made to extend the life of the interior as well as the exterior side of the pipe. When pitting takes place and leaks occur, the cost includes the accompanying loss in pumping time as well as the gasoline lost and the cost of repairs. Even in the early stages of internal corrosion, the excessive wear on pump impellers caused by rust in the gasoline, the cost of maintaining suitable filters or clarifiers for the removal of this rust, and the loss of revenue caused by decreased throughput resulting from roughness of the inside of the line are also expense items chargeablé to corrosion. In view of these facts employment of reasonable means of minimizing internal corrosion is economically justifiable.

Corrosion according to the accepted views requires only the presence of air and moisture in contact with a ferrous metal. Particular cases, however, are greatly complicated and excluded from generalizations regarding intensity and type of corrosion by the numerous chemical and physical variations. In gasoline pipe lines, air and aqueous material are carried by the gasoline as it enters the line, and the supply of air frequently is replenished at pumping stations or at terminal points. The aqueous material usually consists of water and entrained treating solution. Except where copper sweetening is employed, the treating solution is usually spent doctor sludge. The gasoline itself, far from being homogeneous, contains besides hydrocarbons complex compounds of oxygen, nitrogen, and sulfur, some of which are capable of initiating or of altering the rate or direction of corrosion reactions.

When it was found in 1934 that internal corrosion of the gasoline pipe lines had already reached alarming proportions, the problem was attacked from several sides, the principal ones being (1) determination of the factors contributing to this severe corrosion, (2) development of means for determining the rate, type, and extent of corrosion currently taking place, and (3) investigation of various means of reducing the corrosion.

### Factors in Internal Corrosion

In the study of the factors contributing to corrosion, most attention was given to air, water, and treating solutions which may be dissolved in or be mechanically entrained with the gasoline as it enters the pipe line. As an aid in this investigation, a sensitive method was developed for determining the amount of oxygen dissolved in the gasoline, the method being applicable in field tests as well as in the laboratory. At the same time a rather extensive survey was made of the conditions existing in the refinery storage tanks and the pipe-line terminal tanks which were conducive to mechanical entrainment of aqueous solutions with the gasoline. In this connection a method was developed for continuously recording the turbidity of the gasoline stream. The turbidimeter unit, as shown in Fig. 1, consists of a photoelectric cell, an indicating microammeter, a light source, and a turbidity tube. The values tabulated are microammeter readings, which are proportional to the light passing through the gasoline sample. The clearer the gasoline the higher is the microammeter reading.

### SUMMARY

**Experimental investigation of the causes of internal corrosion of gasoline pipe lines has shown air and aqueous-treating solutions dissolved in or mechanically entrained with the gasoline to be the principal factors in barnacle growth and pitting of the pipe. A turbidimeter has been used for measuring the amount of aqueous solution or solids in the gasoline stream.**

**Static, splashing, and circulating methods have been developed for studying the corrosion of pipeline steel under a great variety of conditions. Studies have been made of the effect of (1) volume ratio of the three phases, aqueous solution, gasoline, and air, (2) components of the three phases, (3) condition of the test specimen, (4) velocity of motion of liquids past the surface of the specimen, (5) temperature, (6) solids, and (7) kind of gasoline.**

**As an inhibitor for this type of corrosion, mercaptobenzothiazole has given good results in laboratory, pilot plant, and commercial-scale tests with concentrations of the order of 1 to 2 lb. per 1,000 bbl. of gasoline. Large-scale installations are located on the Phillips pipe line at Borger, Texas, and Laverne, Okla.**

**Test specimens which are withdrawn periodically from the Phillips line for inspection indicate that corrosion has been markedly reduced.**

On the arbitrary scale a value of 30 represents a clear gasoline, 20 a moderately turbid gasoline, and lower readings gasoline of greater turbidity. The results of such tests are shown in Fig. 2, the gasoline in this case having been settled more than 24 hours after doctor treating. In addition to illustrating the operation of the turbidimeter this particular figure shows the effect of disturbances in flow, such as opening or closing lines to the tanks from which gasoline is being withdrawn. The turbidimeter readings in the figure are shown in terms of pounds of lead sulfide per 1,000 bbl. of gasoline. There was associated with the lead sulfide, of course, a definite quantity of aqueous solution.

Since it was desirable to know whether the time required for complete settling was in the practical or impractical stage, considerable attention was given to this phase of the problem. The results given in Table 1 are typical:

**TABLE 1—TURBIDITIES ON NO. 2502 TANK (PIPE LINE)***

| | Samples taken 11:30 4-15-35 | |
|---|---|---|
| | 2:45 p.m. 4-15-35 | 2:00 4-16-35 |
| 1. 3 ft. from top | 20 | 30 |
| 2. 20 ft. from top | 18½ | 28 |
| 3. 1 ft. above sludge | ¼ | 15½ |

*Recirculation finished 1:30 p.m. Apr. 14, 1935.

Another tank which showed even slower settling is shown in Table 2. All of the quart samples were taken at the same time but various periods of settling were allowed before taking the turbidity measurements on a laboratory instrument.

**TABLE 2—TURBIDITIES ON NO. 76 TANK (CRACKED GASOLINE)***

| | Quart samples settled in laboratory | | |
|---|---|---|---|
| | 4-12-35 | 4-13-35 | 4-15-35 |
| Samples taken 4-12-35— | 4:30 p.m. | 8:30 a.m. | 2:45 p.m. |
| 1. 2 ft. from top at 3 p.m. | 13 | .. | .. |
| 2. 8 ft. from top at 3 p.m. | 10½ | 14½ | 26½ |
| 3. 20 ft. from top at 3 p.m. | 9½ | 14 | .. |
| 4. Pump suction, 3:07 p.m. | 8½ | .. | .. |

*Filled 11 p.m. Apr. 11, 1935; transfer started 2:52 p.m. Apr. 12, 1935.

Since most of the gasoline in the United States was being doctor-treated at the time this investigation of corrosion was begun and since the time required for complete settling of the doctor sludge appeared in most instances to be impractical, attention was directed to the effect of spent doctor solution on this problem of internal corrosion of the pipe line. Gasoline thus treated and not subsequently carefully clarified was found to contain varying amounts of caustic soda, lead oxide, lead sulfide, iron oxide, iron carbonate, alkali and alkaline earth sulfates, sodium thiosulfate and iron and lead sulfate associated with water in a more or less stable suspension. Air and sulfur were also found to be present dissolved in the gasoline. Barnacles and scale removed from the line carrying this gasoline were found to contain lead and iron oxides, ferrous carbonate, and alkali, alkaline earth and heavy metal sulfates.

Lead and iron sulfides in the presence of free

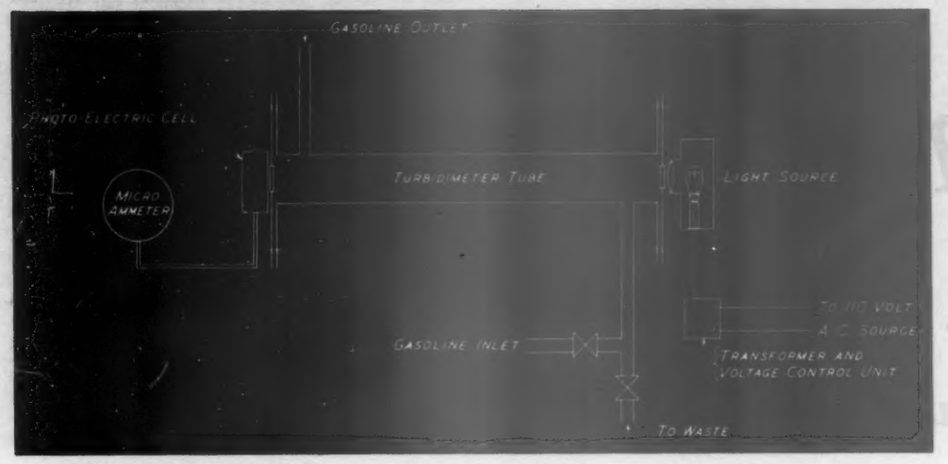


*Fig. 1—Turbidimeter assembly*

oxygen give rise to lead and iron oxides, with the incidental production of thiosulfates, sulfites, sulfates, and free sulfur. Most of these substances are known to be highly corrosive. Furthermore, lead and iron sulfides and oxides by deposition on the metal apparently initiate the formation of corrosion concentration cells. Iron from the pipe dissolves in the anodic areas screened from contact with oxygen by the deposit of lead or iron sulfide. As this iron in solution diffuses toward the periphery of the anodic regions where the alkalinity is higher, iron hydroxide is precipitated, giving rise to pitting and barnacle formation. The continuation of this process is favored by the presence of free oxygen. It has also been found that localized corrosion is more severe in regions where the solid and aqueous material is less evenly dispersed in the gasoline.

The amount of lead sulfide and other substances normally associated with doctor treating may be considerably reduced by special clarification methods, or it may be eliminated entirely by substitution of copper sweetening for doctor treating. Thus, the amount of the corrosive materials mentioned above as present in the gasoline may be minimized, but the possibility of complete removal of air and water is distinctly limited. To retard the corrosive action of air and water present in the line, addition of a corrosion-inhibiting chemical to the gasoline seems to be the most feasible method.

## Corrosion Inhibitors

The term corrosion inhibitor is a familiar one much in evidence in scientific and patent literature. There is not a single class of inorganic or organic compounds which has not been tested at one time or other for its effectiveness in preventing corrosion. Yet with this abundance of data the investigation of inhibitors of internal corrosion for a gasoline pipe line was almost entirely one without benefit of precedent.

Inorganic inhibitors which are satisfactory in many applications are ruled out because of very limited solubility in hydrocarbon oils, which in this case must be depended on as the primary carrier for the inhibitor. Effective organic inhibitors must satisfy these conditions: (1) They must be soluble in both the gasoline and aqueous phases, the gasoline solubility being great enough ao assure that the compound will be carried through the pipe line and not be completely extracted by contact with the aqueous phase always present; (2) they should not be rapidly rendered inactive by reaction with any component of the gasoline or of the aqueous solution in the line; (3) they must not cause the deterioration of any property of the gasoline such as color, odor, or antiknock rating, nor should they make the gasoline sour or corrosive; (4) to be most effective it appears that at least part of the molecule of the substance should possess a definite affinity for the metals, protection of which is desired. It is obvious that many materials with corrosion-inhibiting properties are unsatisfactory by one or more of the above-mentioned criteria.

## Laboratory Corrosion-Test Methods

After the conditions of operation of the gasoline pipe lines had been ascertained and an appropriate picture of the materials entering and the reactions taking place within the line had been secured by examination of the line and corrosion products, the next step was to devise test methods which would approximate the pipe-line conditions as closely as possible and which would permit individual evaluation of the numerous factors entering the picture. Thus, in selecting laboratory corrosion-test methods the variables which received most attention were: (1) Conditions of the test specimen; (2) volume ratio of the three phases, aqueous solution, gasoline and air or other gas in contact with the specimen; (3) components of these three phases; (4) velocity of motion of liquids past the surface of the specimen; (5) temperature; (6) effect of solids; (7) the kind of gasoline used.

The various test methods used in the laboratory to test compounds for inhibiting value are perhaps of interest. Physically the methods might be divided into two types, static and circulating. In the static tests strips of pipe-line steel whose surface had been prepared by a carefully standardized procedure were allowed to stand in contact with an aqueous and a gasoline phase. The results of these tests served merely to eliminate compounds which were obviously ineffective as inhibitors.

Another type of test relied upon for preliminary investigation was the splash test. The container used was a glass-stoppered tube of about 200 ml. capacity with a test bar ⅜ by ⅜ by 3½ in. inserted at right angles to the bore (about 1 in.) of the tube. By turning the tube in a circular orbit, the bar was constantly washed by the materials in the tube. Contents of the tube under average test conditions were as follows: 100 ml. of gasoline and 2 ml. diluted spent doctor solution (10 per cent in distilled water) with 0.1 g. sodium thiosulfate and a small amount of lead sulfide sludge added. This lead sulfide was obtained from refinery-storage tank bottoms. The concentration of thiosulfate was much higher than is found in the pipe line, but was maintained to accelerate the corrosion of the test bars. Blank tests under these conditions showed rust on the bars in an average period of three days. The tube is shown in Fig. 3.

In the event that good results were obtained with any compound in the preliminary tests, after checking these first results, the next step was to try the compound in a circulating test. Circulation of gasoline and spent doctor solution over a test bar was obtained by means of a mechanical stirrer in a specially designed glass vessel. For an average test, contents of the vessel were about 2 l. of gasoline and 20-30 ml. of diluted spent doctor solution with sodium thiosulfate, lead sulfide sludge, and powdered iron oxide added. The average period before corrosion with this method was 7 days, but pipe-line conditions were more nearly approximated. The apparatus for this test is illustrated in Fig. 4.

A further adaptation of the circulating test was made by circulating gasoline and aqueous solutions by means of a small centrifugal pump through a closed-glass system. The bars rested in a horizontal tube, and velocity effects were particularly noticeable in this apparatus as well as the effect of solid particles in the stream. This test was not extensively used because of the slowness of the corrosion reactions.

## Laboratory-Test Results

By means of the test methods described above, pipe-line conditions could be simulated and the effect of various factors could be exaggerated. The conclusions reached from several years of testing with these types of apparatus are summarized herewith.

Corrosion was found to be more rapid on rough surfaces than on smooth surfaces, due perhaps to the difficulty of removing the last traces of adhering scale and rust from surface pits and scratches. Pickling the test bars to remove rust left the surface so active that corrosion took place immediately on removal of the bars from the acid bath. Thus it was necessary to follow the pickling operation with a light wire brushing which, when done so as to avoid excessive heating of the bar, left a bright surface practically free of rust even in pit bottoms. Bars cleaned in this manner and immersed in a benzene-ether mixture remained untarnished long enough to allow a convenient period between the cleaning process and the actual beginning of the test.

In the absence of any aqueous phase, no corrosion occurs on steel bars immersed in gasoline. The aqueous phase used in laboratory tests varied

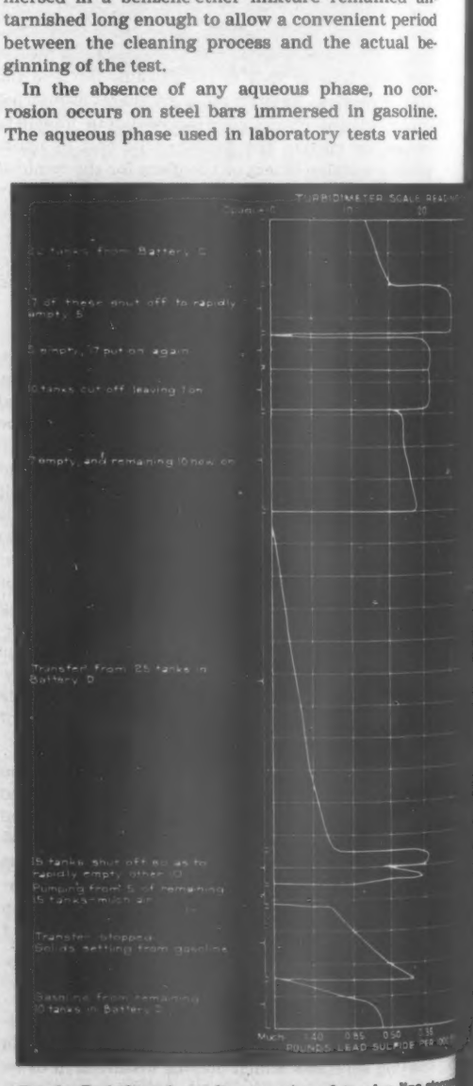


*Fig. 2—Turbidity of gasoline transferred to pipe-line storage*

from tap water to concentrated tank-bottom sludge, and the volume ratio from 4 per cent to 0.1 per cent. It was noted that within this range the rate of corrosion was greatly increased when insufficient aqueous material was present to continually wet the entire test piece, but with very small amounts of aqueous phase the ultimate extent of corrosion was appreciably decreased. For this reason 2 per cent of aqueous phase was used in most of the

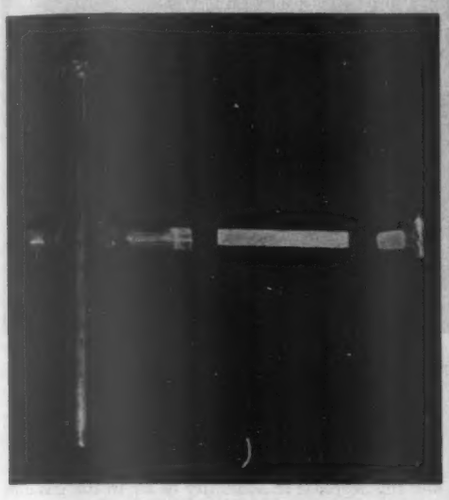

*Fig. 3—Apparatus used for splash tests*

tests as a convenient medium value. It was also found that increasing the pH of water solutions present decreased the rate and amount of corrosion so the solutions used most were (1) 0.25 N-NaOH solution; (2) 10 per cent spent doctor; (3) 5 per cent new doctor. Of these, spent doctor solution was most corrosive, due to its content of dissolved salts, chiefly thiosulfate. As an accelerating measure, as much as 50 mg. sodium thiosulfate was added per milliliter of the 10 per cent spent doctor. A similar accelerating effect was ob-

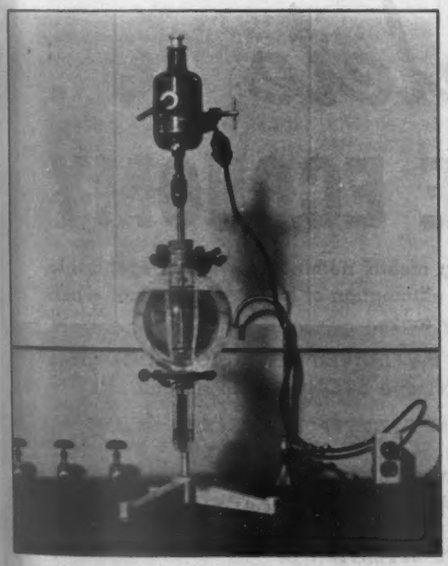

*Fig. 4—Apparatus used in circulating tests*

tained by adding sodium sulfide to either spent doctor or to sodium hydroxide solution. The corrosive action of these compounds is undoubtedly due to their participation in oxidation-reduction cycles in the course of corrosion reactions.

Variation of the oxygen concentration did not have as marked effect as anticipated. Use of pure oxygen instead of air or of oxygen under pressure did not proportionately increase the corrosion rate due to the formation of a partially protective oxide film on the test bars. Replacement of air in the test vessels by nitrogen length-

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ened slightly the period before the beginning of corrosion, but once started, the only difference was apparently in the end products of corrosion reactions. An intermediate oxygen concentration gave most consistent results. This was obtained in splash tests by having about 100 ml. of air in contact with 100 ml. gasoline and aqueous material.

A marked difference was noted in the tests using different kinds of gasoline. With low-boiling naphthas, natural gasoline and some straight-run gasolines, corrosion under similar conditions was worse than with cracked gasoline. This must be due partly to the presence of natural inhibitors such as cresols and naphthenic acids in cracked gasoline. For standard tests a third-grade gasoline was used as a medium between the extremes of cracked and natural gasolines.

The effect of added solids was two fold. Where nonreactive particles such as sand or iron oxide would settle on the surface of the test bar, corrosion would localize due to a screening or concentration cell action. The other solid substance consistently added in tests was lead sulfide either as tank-bottom sludge or the pure compound. This substance was more or less rapidly oxidized during tests, forming lead oxide and sulfur. Acceleration by the pure compound was much greater than by the lead sulfide sludge due to the fact that the particles of the latter were coated with impurities and reacted less rapidly.

Changes in flow velocity in tests conducted in circulating systems did not make themselves readily apparent through different rates of corrosion. Increased velocities in these tests appeared to decrease the amount of corrosion on surfaces which were so located that the flow velocity past all portions of the surface was uniform. Any shielding of flow or quiet regions on the bar surface such as points of contact with the test vessel or projection of the bar into quiet areas gave rise to regions of rapid corrosion. Thus in closed system circulating tests conducted in a horizontal tube, the face of the bar resting on the bottom of the tube would collect solid particles from the liquid and corrode rapidly while little or no corrosion occurred on the rest of the bar. Otherwise higher velocities resulted in more uniform but less severe corrosion.

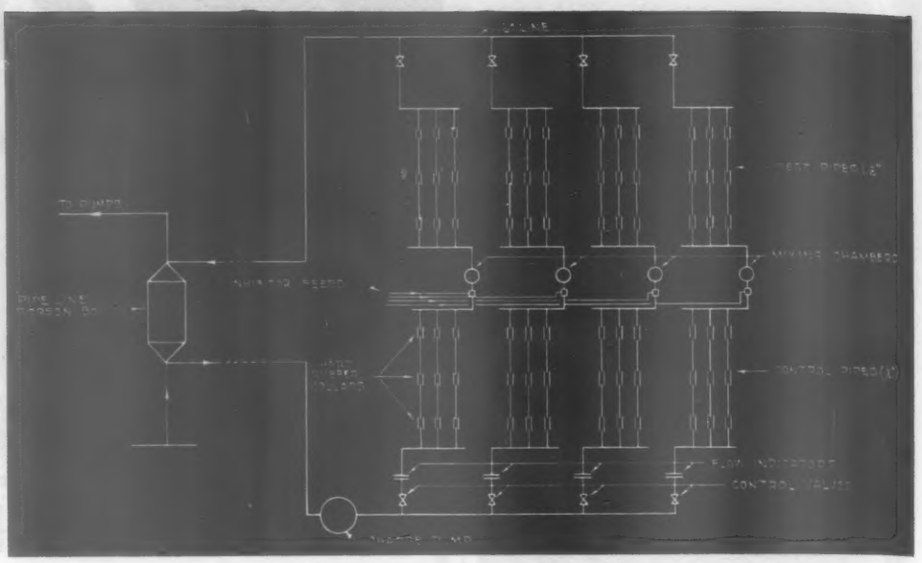

*Fig. 5—Field pipe-line inhibitor—test assembly*

All the laboratory tests were carried out at temperatures ranging from 70° to 115° F., usually at normal room temperatures. Acceleration of corrosion reactions which was anticipated would occur with higher temperatures was not realized in these laboratory tests because they were conducted in glass vessels at atmospheric pressure and the decrease in solubility of air in the gasoline offset the effect of the higher temperatures. In actual pipe-line operation there is no change in oxygen concentration with temperature, hence corrosion is accelerated with increasing temperature. This has been confirmed by inspection of pipe-line specimens during the winter and summer seasons respectively.

Results of the laboratory tests indicated that sodium thiosulfate and lead sulfide are definitely


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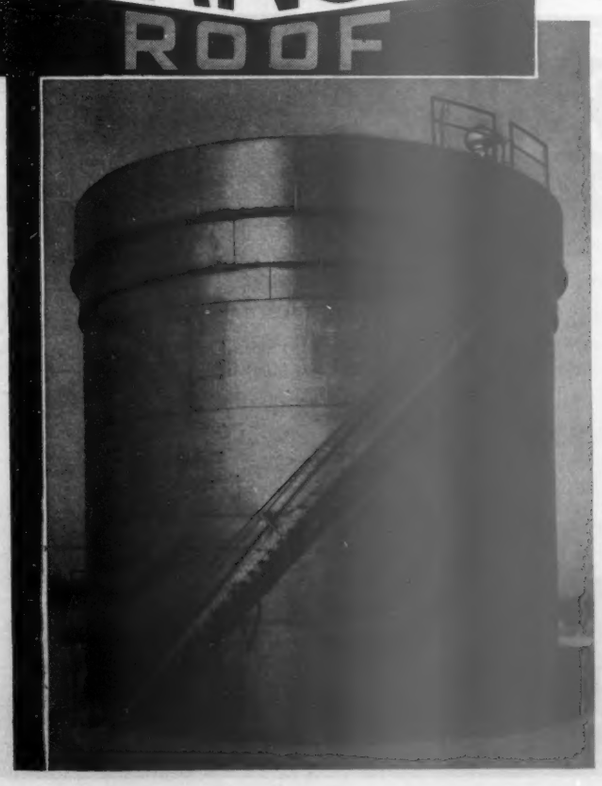

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corrosion accelerators. Sodium carbonate appears to play an intermediate role in barnacle formation. A homogeneous mixture of gasoline and the various liquid and solid materials found in the line favored uniform corrosive action rather than pitting. By using these methods it was also possible to determine the corrosion inhibiting ability of various chemicals using an alkaline aqueous-gasoline mixture which reproduced pipe-line conditions as nearly as possible. Of the several hundred organic and inorganic inhibitors tested in this way only a few showed sufficient promise to warrant larger scale work.

The laboratory investigation of several hundred chemicals under the many varied conditions led to the discovery that the presence of mercaptobenzothiazole in gasoline inhibits the corrosion of the metallic vessels or pipe lines with which the gasoline is in contact. In order to test this compound, as well as certain others which showed somewhat less promise, on a larger scale, a pilot plant was constructed at the inlet terminal of the Phillips' pipe line at Borger, Tex. This location was chosen since early observations had indicated that corrosion was most severe in the first 50-mile interval from the refinery. The pilot plant was installed as a bypass on the main line as shown in the accompanying diagram, Fig. 5, field pipe-line inhibitor test assembly, which is a flow sheet of the pilot plant. The inhibitor was then fed into this bypass. Removable test nipples were installed ahead of and behind the inhibitor feeder on the bypass line. The velocity of gasoline passing through the test and control nipples was identical. The single variable involved was that the test nipple was in contact with inhibited gasoline and the control nipple was not. As will be seen from an inspection of the flow sheet, provision was made for operation of four tests with different inhibitors or different concentrations of the same inhibitor at one time and for having duplicate nipples in each test, as well as for using nipples with different past histories such as sand-blasting, pickling, etc. Mixing chambers and piston injectors were used to insure a homogeneous mixture of inhibitor and gasoline. The nipples were connected by insulating collars to prevent electrical effects. Since this bypass was operated in conjunction with operation of the main line, the effect of line rate and changes in concentration of air, water, and other chemicals in the gasoline was identical on the control and test nipples. The apparatus was set up in such a way that the velocity of gasoline through the test units could be controlled. In most of the experiments this was maintained at that of the main line. When it was desired to inspect the nipples they were removed and split lengthwise.

The results of this pilot-plant work showed mercaptobenzothiazole to be the most satisfactory inhibitor. The accompanying photographs (Figs. 6a, b, c, d, e) of nipples removed from the pilot plant illustrate the difference between the appearance of control and test nipples. The attack on the control or blank pipes was very severe and general whereas little corrosion was evident on the test pipes. Duplicates were always made so that interpretation of the results would be more certain. The inside of the test nipples which had been in contact with inhibited gasoline was covered with a smooth, amorphous yellow-green deposit and was not rusted even under this deposit, while the inside of the control nipples was attacked by rust. Mercaptobenzothiazole is pale yellow and in combination with iron or iron oxide becomes greenish yellow, so that it is quite likely the deposit found was an iron complex with mercaptobenzothiazole. These and other tests indicated that a concentration of 1 to 2 lb. of inhibitor per thousand barrels of gasoline gave the most satisfactory protection. Tests made with nipples which had previously been allowed to be attacked by rust indicated that mercaptobenzothiazole under conditions existing in the line at that


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time, i.e., a fairly alkaline water phase, would inhibit further rusting and cause the rust which had already been formed to gradually drop off and be replaced by a smooth yellowish green coating. This latter fact is very important in use of mercaptobenzothiazole in a pipe line covered by mill-scale or previously rusted.

In connection with this pilot-plant work the effect of mercaptobenzothiazole on the properties of the gasoline was investigated with extreme care and thoroughness. No deleterious effect on color or color stability, gum or gum stability, octane number or lead susceptibility, or other characteristics could be detected when the concentration of the inhibitor is that used for corrosion inhibition.

## Addition of the Inhibitor to the Pipe Line

The information obtained by laboratory and pilot-plant experiments indicated that addition of mercaptobenzothiazole to the pipe line was warranted. Although a circulating test with several hundred feet of pipe was made with favorable results, it was impossible to know from pilot-plant studies the length of line to which protection could be afforded by one feeding unit. In order to determine this a feeding unit was installed at the inlet terminal of the line. The accompanying diagram, Fig. 7, sketch of mercaptobenzothiazole feeding unit, illustrates the equipment used. The solid mercaptobenzothiazole was mixed with flushing oil (Saybolt viscosity 75-80 seconds at 100° F.), 2 lb. of mercaptobenzothiazole per gallon of oil making the most satisfactory slurry. Since this suspension will settle on standing, equipment was provided for constant agitation. This oil slurry was pumped at the rate of 1 lb. of mercaptobenzothiazole per 1,000 bbl. of gasoline into a bypass taken off the main line. Since the mercaptobenzothiazole slurry could not be pumped into gasoline under a pressure of greater than 25-30 lb. per sq. in., it was necessary to reduce the main-line pressure of 50-125 lb. per sq. in. to 15-20 lb. per sq. in. in the bypass, then provide a suitable pump for returning the gasoline-inhibitor concentrate to the main line. Another type of installation using the sump pump connections in place of the bypass arrangement is used at the Laverne station. The capital investment of installations of this type is of the order of $500.

During the progress of these studies it was, of course, necessary to devise means of determining the progress of internal corrosion in the line, and the length of pipe to which corrosion protection was being afforded. Since opportunity to see the inside of an operating line is extended only at very infrequent intervals, as when a "line break" occurs or during reconditioning, indirect methods were developed to secure this information. These consisted of analysis of the gasoline for its mercaptobenzothiazole content at various points along the line and installation of steel-test specimens suspended in the line, which could be removed for inspection from time to time.

Since the concentration of mercaptobenzothiazole used for corrosion protection is very small, of the order of a few milligrams per gallon, very delicate methods of analysis had to be developed. A volumetric and a gravimetric method were devised, both making use of the very insoluble salt formed by the reaction of mercaptobenzothiazole and silver nitrate. Although certain modifications of mercaptobenzothiazole, which quite likely occur in the line and have corrosion inhibiting properties, are not determined by these methods, the latter have been useful in following the inhibitor in the line.

## Inhibitor Life

The pilot plant corrosion tests conducted under actual operating conditions indicated conclusively that mercaptobenzothiazole in concentrations as low as 0.00016 weight per cent, or the equivalent of 11 lb. per 25,000 bbl., was adequate to substantially eliminate corrosion from the test specimens. In the application of this material to the pipe line, however, the question arose as to the life of the inhibitor, or in other words the distance from the point of addition the inhibitor would travel and afford protection. It was believed that conditions within the line, such as the amount of water, caustic treating solutions and sludge would always play an important role, and this was confirmed in large scale operation. An-

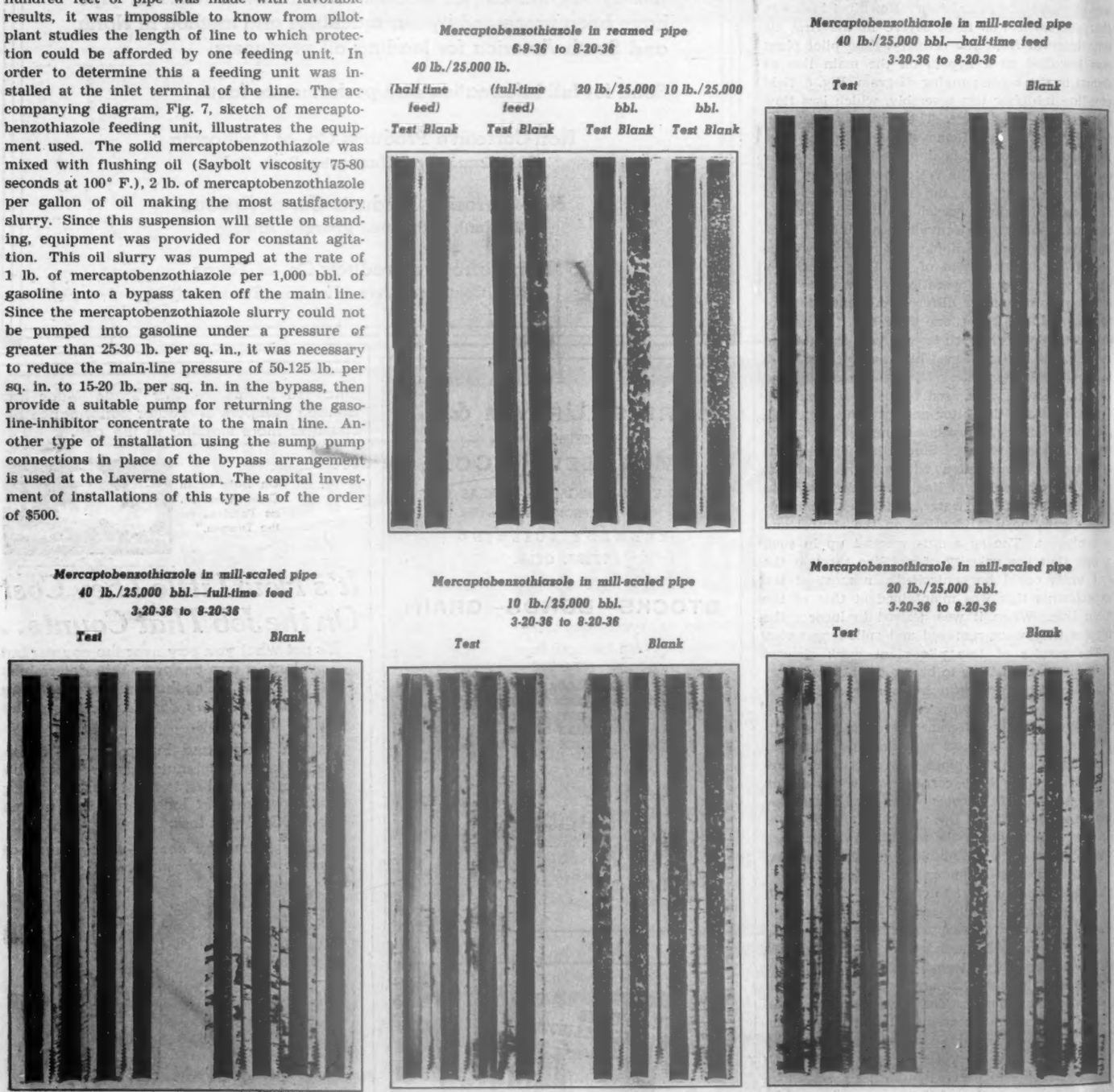


*Fig. 6—A-B-C-D-E—Phillips pipe-line corrosion inhibitor tests*

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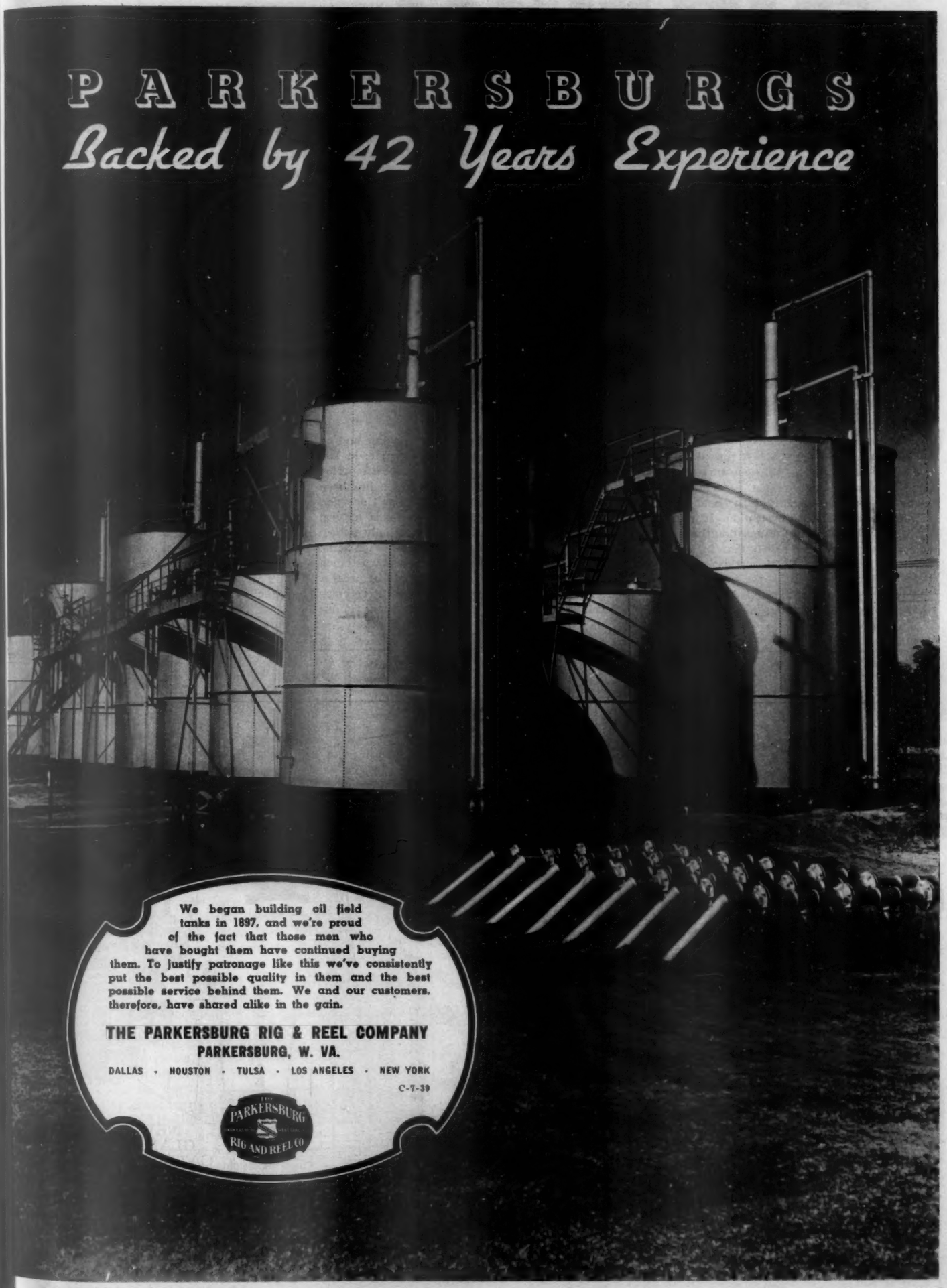

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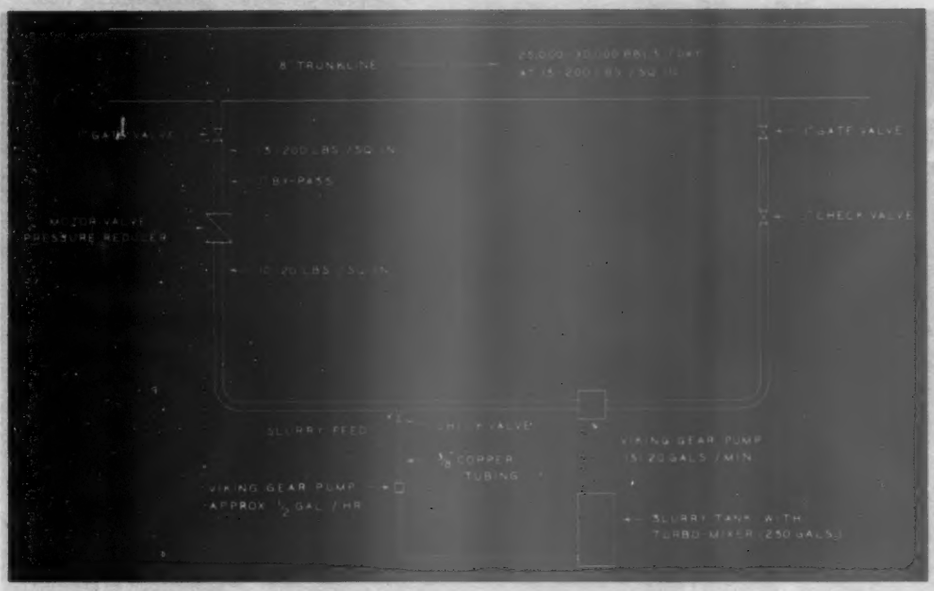


*Fig. 7—Sketch of MBT feeding unit*

alyses showed that in the beginning very little inhibitor reached even the first pumping station, a distance of 14 miles. With continued introduction of the material, however, the distance traveled seemed to increase steadily until about 100 miles of the line was afforded protection. It was found, too, that in certain slugs of gasoline the inhibitor disappeared much more slowly than in other shipments. A great amount of investigative work has been done on this phase of the problem, some of the results being mentioned below.

The life of the inhibitor depends to a great extent on the kind and source of gasoline and on the method of sweetening. For example, in laboratory tests the mercaptobenzothiazole life period in West Texas cracked gasoline which has been doctor treated is frequently as short as 1 day and seldom more than 3 days. West Texas natural gasoline, also doctor treated, has usually shown a life period of 4 days or less. On the other hand, Mid-Continent natural gasoline may show as much as 60 or 70 per cent of the inhibitor to be present after as much as 7 days. Mid-Continent refinery gasolines have longer life periods than similar stocks from West Texas crudes. If copper sweetening is employed instead of doctor treating, the mercaptobenzothiazole life period is usually rather markedly increased in laboratory tests. Typical results are shown in Tables 3 and 4.

**TABLE 3—A COMPARISON OF THE RATE OF DECOMPOSITION OF MERCAPTOBENZOTHIAZOLE IN DOCTOR AND COPPER-TREATED NATURAL GASOLINE**

| | Per cent of original amount present after storage | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Days | | | | | | | |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Doctor sweetened | 80 | 70 | .. | 40 | .. | 0 | .. | .. | .. |
| Copper sweetened | 80 | 80 | .. | 60 | .. | 40 | 20 | 10 | 0 |

**TABLE 4—A COMPARISON OF THE RATE OF DECOMPOSITION OF MERCAPTOBENZOTHIAZOLE IN DOCTOR AND COPPER-TREATED NATURAL GASOLINE**

| | Per cent of original amount present after storage | | | | | | |
|---|---|---|---|---|---|---|---|
| | Days | | | | | | |
| Series 1— | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Doctor | 80 | 50 | 10 | 0 | .. | .. | .. |
| Copper | 80 | 60 | 45 | 20 | 0 | .. | .. |
| Series 2— | | | | | | | |
| Doctor | 80 | 40 | 10 | 0 | .. | .. | .. |
| Copper | 80 | 75 | 40 | 10 | 0 | .. | .. |

These laboratory results seem to indicate that the presence of polysulfides in doctor-treated gasolines is an important factor influencing the rapid decomposition of mercaptobenzothiazole in gasoline stocks treated by the doctor method.

In addition to the method of sweetening employed on the gasoline, other important factors are pipe-line sludge and those oxidation products present in cracked gasoline, such as peroxides and gum-forming constituents. Table 5 shows that the more stable sulfur compounds such as the mono sulfides and disulfides have very little or no effect on the mercaptobenzothiazole. Hydrogen peroxide oxidizes it almost instantly and organic peroxides also react rather rapidly.

Since the amount of inhibitor is so small and


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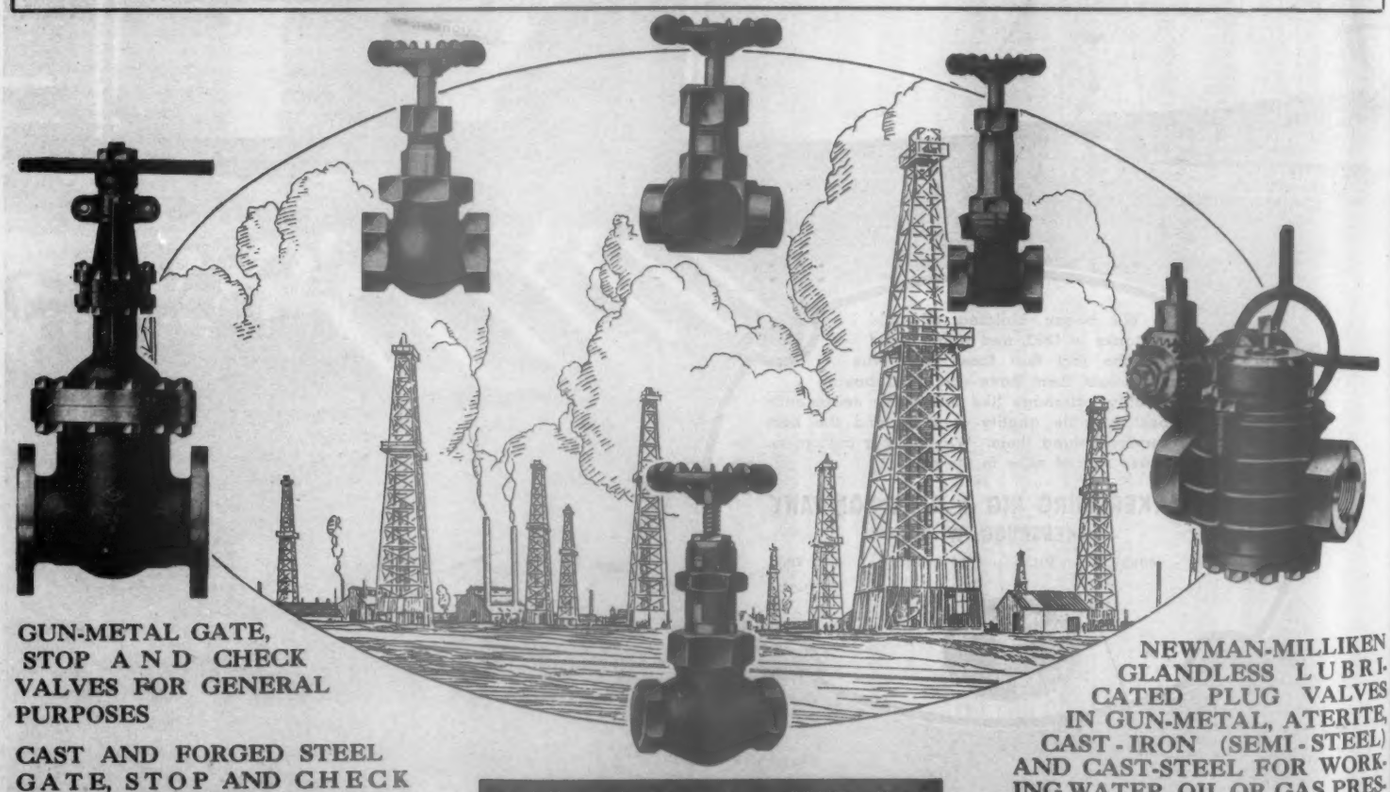

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the impurities in the gasoline so greatly influence its life period, it is impossible to draw general conclusions which would be adaptable to gasoline pipe lines in general. It should be possible, however, after suitable investigative work to determine the amount of inhibitor which should be added to any particular pipe line.

TABLE 5—RATE OF DECOMPOSITION OF MERCAPTOBENZOTHIAZOLE IN REFERENCE FUEL CONTAINING VARIOUS SULFUR COMPOUNDS

| | Per cent of original amount present after storage | | | |
|---|---|---|---|---|
| | Days | | | |
| Reference fuel plus— | 0 | 2 | 3 | 6 |
| (A) Methyl sulfide, 0.25% | 95 | .. | .. | 80 |
| (B) Free sulfur, 0.5% | 95 | 90 | .. | 80 |
| (C) Ethyl sulfide, 0.25% | 95 | .. | 75 | 80 |
| (D) Ethyl disulfide, 0.25% | 95 | .. | 75 | 25 |
| (E) Ethyl sulfide and disulfide, <0.5% | .. | .. | 75 | 50 |
| (F) Ethyl sulfide and free sulfur, <0.5% | .. | .. | 75 | 80 |
| (G) Ethyl disulfide and free sulfur, <0.5% | .. | .. | 75 | 80 |
| (H) Propyl polysulfide (a propyl mercaptan solution sweetened with polysulfide), 0.5% | 90 | .. | 50 | 20 |
| (I) Ethyl trisulfide, 0.25% | .. | .. | 90 | 50 |

### Pipe-Line Test Bars

As a means for observing the state of the line, test bars were inserted in the Phillips pipe line at carefully selected points. The test specimens used consisted of a strip of steel of the same composition as the pipe supported in a vertical position inside the line. The engineering details of the specimen and the method of placing it in the

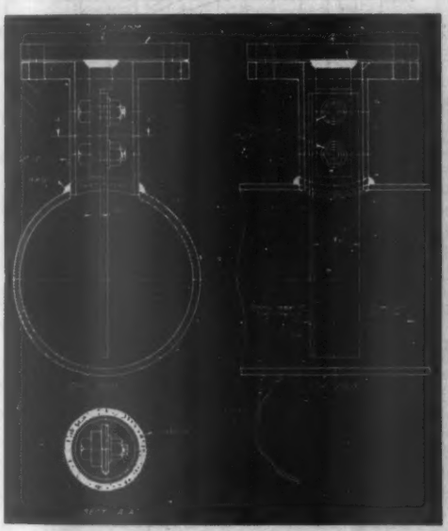

*Fig. 8—Details of corrosion-testing device*

line will be found in the accompanying drawing. (Fig. 8.) These test devices have been located in the entire line at approximately 20-mile intervals. By removing and examining them from time to time it is possible to get information about internal pipe-line conditions.

By a correlation of the results of analysis and observation of condition of the test bars over a period of 18 months' operation of the original feeding unit, it was found that the mercaptobenzothiazole was being carried a distance of about 100 miles. Small amounts of mercaptobenzothiazole could be detected in the gasoline at this distance and the test bars in this area were less attacked by rust than those beyond this section, the ones nearer the inhibitor feeding station being covered by a smooth greenish yellow film.

In view of this information a second inhibitor-feeding unit operating in an identical manner with the original unit was installed 110 miles from the inlet terminal of the line. At the present time, it is believed that these two feeding units are sufficient to provide the beneficial results of the inhibitor over the desired section of this pipe line.


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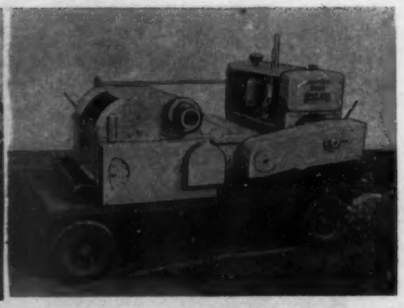

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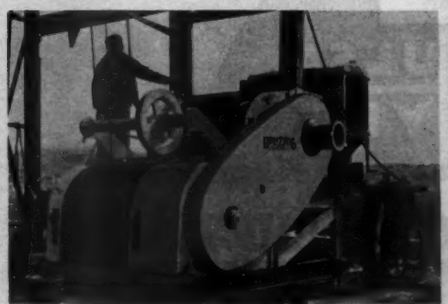

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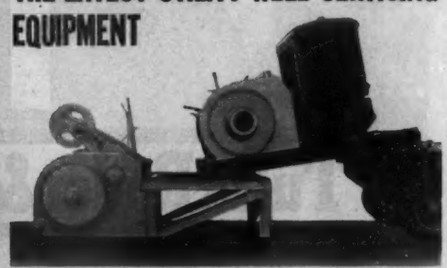

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## Oil-Country Tubular Goods

*(Continued from Page 103)*

the line of thought used by Euler, Tetmajer, and others, to explain the buckling of long slender columns.

This writer has followed very closely the work of William Howard Clapp, of California Institute of Technology, in his long-column work. Clapp does not find it necessary to throw away the fundamental concept that permanent deformation does require exceeding the elastic limit of the material. In fact, he demonstrates at what point the elastic limit is exceeded.

It seems to this writer that, except for Clapp's work, we are getting entangled hopelessly in such unorthodox concepts as "reduced yield strength," "critical stresses lower than the yield strength," "reduced modulus of elasticity," etc. These terms imply that just because a given piece of steel is in tubular form, instead of fabricated into round or flat test bars, its elastic properties are different. In fact, the implication is that a test piece machined out of the side wall of a piece of oil-well casing would exhibit a different proportional limit, a different modulus, elastic limit, and yield strength than if the entire tube were subjected to collapsing pressure.

The author contends that our failure to find a simple, rational, relation between stress, pressure, and the tube proportions does not mean that no relationship exists. He also contends that the injection of these trick phrases and terms merely tends to confuse, rather than to help, the issue.

**Photoelastic evidence.**

It was hoped that a fairly complete photoelastic stress-analysis study would be ready for this discussion; but we found that some of the difficulties in producing pure hoop stress, pure bending stress, and a combination of the two were almost insurmountable. It is hoped that a better representation from this angle will be ready at a later date.

**Combined hoop and bending-stress formula.**

At any rate, if we can evaluate these bending and hoop stresses properly, we should be able to add them vectorially and establish the most intense stress in terms of the tube proportions, and

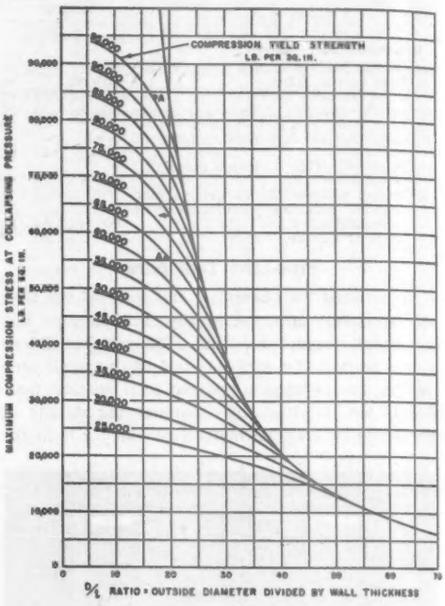
COMPRESSION YIELD STRENGTH
LB. PER SQ. IN.
MAXIMUM COMPRESSION STRESS AT COLLAPSING PRESSURE
LB. PER SQ. IN.
D/t RATIO • OUTSIDE DIAMETER DIVIDED BY WALL THICKNESS

*Fig. 5—Bending-stress-formula curves*

determine the pressure which will generate this stress. Such a procedure should bridge the range of tube proportions in which we are interested. In this connection, it should be kept in mind that any residual stresses either will add to or will detract from our result.

Because this writer is loyal to the maximum-strain energy theory, the hoop-stress formula he must select is:

$$S_H = P\sqrt{\frac{2(1+\mu)k^4+2(1-\mu)}{(k^2-1)^2}}$$

*Where:*

$S_H$ = the hoop stress.

$$k = \frac{\frac{D}{t}}{\frac{D}{t}-2}$$

The big problem in this derivation is to get the pure bending stress that can be added to the hoop stress above, and relate these stresses directly to the tube proportions.

Of all of the investigators in this problem, the French mathematician, J. A. C. H. Bresse,[7] as

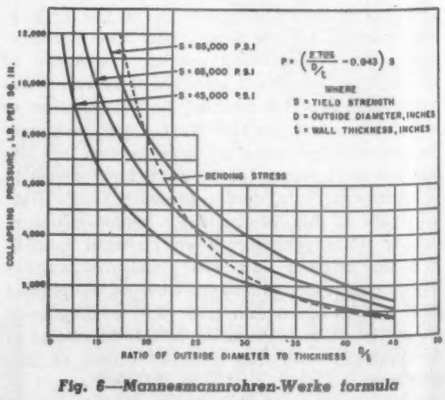
S = 85,000 P.S.I.
S = 65,000 P.S.I.
S = 45,000 P.S.I.
P = (E t/D/t − 0.943) S
WHERE
S = YIELD STRENGTH
D = OUTSIDE DIAMETER, INCHES
t = WALL THICKNESS, INCHES
BENDING STRESS
COLLAPSING PRESSURE, LB. PER SQ. IN.
RATIO OF OUTSIDE DIAMETER TO THICKNESS D/t

*Fig. 6—Mannesmannrohren-Werke formula*

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early as 1850 attacked this problem from the most useful angle. He found that the bending stress in a hollow right circular cylinder, very slightly out-of-round, when subject to external pressure, was:

$$S_B = \frac{3Pa^2e^2}{2t^2}$$

where $a$ is the maximum radius, and $e$ is the familiar conic ellipticity. When this ellipticity increases—as it does with increasing external pressure—the increased ellipticity $e$ has the following relation to the infinitesimal original value $e_o$:

$$e^2 = \frac{e_o^2}{1-\frac{P}{2E}\left(\frac{t}{D}\right)^3}$$

Hence, according to Bresse:

$$S_B = \frac{3EPD^2e_o^2}{8t^2\left[1-\frac{P}{2E}\left(\frac{t}{D}\right)^3\right]}$$

The right-hand term in the denominator of this expression resembles our series of bending-stress formulas so closely that it is obvious how Bresse arrived at this conclusion.

As $e_o^2 = \frac{a^2-b^2}{a^2}$, we can get to the tube proportions very easily. In fact, it can be shown by vectors that when $a^2-b^2 = t^2/2$, these bending stresses really begin to take hold.

This makes the bending stress alone, by following Bresse, and by introducing the concepts of the maximum-strain energy theory:

$$S_B = \frac{3EP}{4E-2P(1-\mu^2)\left(\frac{D}{t}-1\right)^3}$$

The total stress is, therefore:

$$S = \frac{3EP}{4E-2P(1-\mu^2)\left(\frac{D}{t}-1\right)^3} + P\sqrt{\frac{2(1+\mu)k^4+2(1-\mu)}{(k^2-1)^2}}$$

plus or minus any residual stress.

This equation looks rather formidable; but, as mentioned previously, perhaps a simple relation that is accurate is hard to find. And also, perhaps,

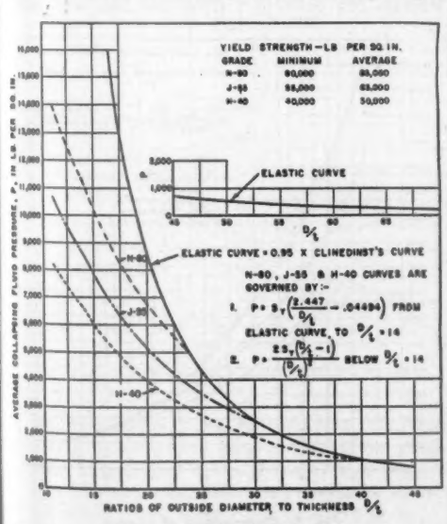
YIELD STRENGTH—LB PER SQ. IN.
GRADE MINIMUM AVERAGE
N-80 80,000 85,000
J-55 55,000 63,000
H-40 40,000 50,000
ELASTIC CURVE
ELASTIC CURVE = 0.95 X CLINEDINST'S CURVE
N-80, J-55 & H-40 CURVES ARE GOVERNED BY:-
ELASTIC CURVE, TO D/t = 14
BELOW D/t = 14
AVERAGE COLLAPSING FLUID PRESSURE, P, IN LB. PER SQ. IN.
RATIOS OF OUTSIDE DIAMETER TO THICKNESS D/t

*Fig. 7—Average collapsing pressure A.P.I. Grades H-40, J-55, and N-80*

some clever individual will uncover a more simple relation that will be accurate enough.

**Results from use of this formula.**

Using this equation, we have plotted a family of curves showing the relation of a constant pressure to stress and the $D/t$ ratio (see Fig. 8). These curves should be very interesting. They show that 1,000 lb. per sq. in. pressure gives slowly increasing stresses from about 2,000 lb. per sq. in. (i.e., about 2P) at $D/t = 2$, to about 20,000 lb. per sq. in. where $D/t = 35$. From this point on there is an abrupt elbow in the curve, and at $D/t = 40$ the stress is up to 30,000 lb. per sq. in., whereas at 40.5 the curve rises almost perpendicularly. This means that, when one has a tube with a $D/t$ of 40.5, it makes little, if any, difference how high the yield strength is above 50,000 lb. per sq. in.

If any one of these constant-pressure curves is followed up to the proper $D/t$ value, it also will go practically straight up.

The easiest way to arrive at a constant-stress curve is to take this family of constant-pressure curves and select the stress desired (e.g., the yield strength of the steel in question), and follow that stress straight across the various pressure curves. The $D/t$ value for the intersection of these pressure curves with a constant stress will permit you to plot the curve of collapse pressure for any grade of steel.

This has been done for the three grades of casing now regularly being supplied under A.P.I. Standards No. 5-A (see Fig. 9).

It will be noted that the curves come very close indeed to those established by Mr. Dunn, who stuck to the test data regardless of the many theories that were thrown at him.

They approach, although they do not precisely coincide with, the so-called "elastic curve" at appropriate values of $D/t$ for each grade. And they all wind up together somewhere in the region of $D/t = 40$.

Checking the region between $D/t = 16$ to 32, in which this curve is partly above and partly below Mr. Dunn's curves, it was found that all the collapse pressures—when residual stresses were low—reported by Mr. Frame[3] in his paper "Casing Setting Depths Are Not Assured by Physical

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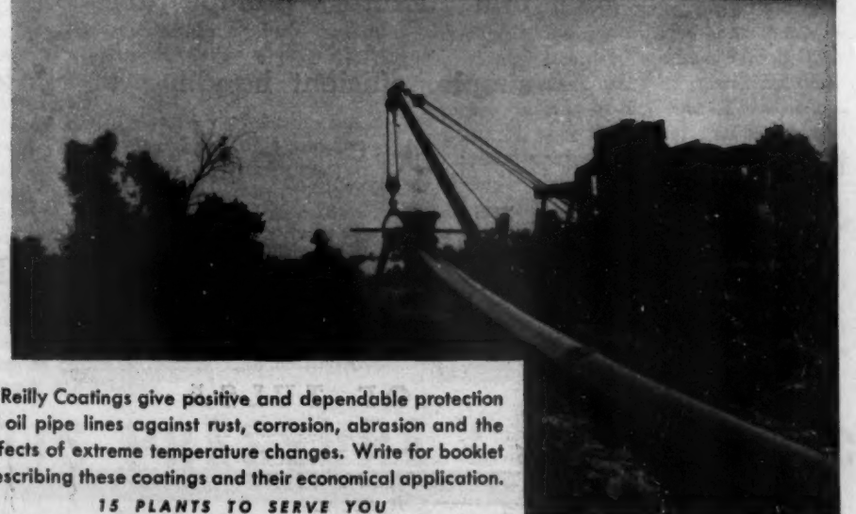

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Properties of the Steel," as well as all the data from our own company, fall above (or directly on) these new curves—although in the region where this curve is below Mr. Dunn's, the majority of tests fall below his curve, i.e., between the two curves.

In connection with Frame's data, it was found that when the residual stress as reported by Frame was fairly high, the stress as calculated by this new formula, plus Frame's residual stress, checks fairly closely with the yield strength in compression. This writer does not agree with Mr. Frame in his method of determining residual stress—but is not making a point of the matter, because he has no better method to suggest. However, of all the residual stresses reported by Mr. Frame, those having sizable values have the best chance of being uniform and accurate.

**Effect on setting depths.**

You will note that, in this new formula, stress and pressure are not directly in proportion. As a matter of fact, they are apparently not directly in proportion according to Dunn, nor according to Jasper's data.

Safety factors — and, therefore, safe setting depths—must be based on stress, not pressure. Let us take, as an example, a steel that has an established average yield strength of 65,000 lb. per sq. in. Refer now to the constant-pressure curves shown in Fig. 8, and locate the points where 32,500 lb. per sq. in. stress crosses these constant-pressure curves; you will have the pressure necessary to produce half the yield stress of this J-55 casing. These values are plotted as Curve 1 in Fig. 10. Twice the pressures determined by this constant-stress curve then will be the setting depth in feet for a factor of safety of 2 with 72 lb. of mud. This curve (4), as you will note, comes uncomfortably close to the pressure necessary to collapse the tube, when $D/t$ ratios around 40 are considered.

The writer has drawn in another curve (3), which he considers to be the most reasonable solution. In this curve, which virtually splits the difference between the old system and the one here proposed, the stress varies from 10,000 lb. per sq. in. (a factor of safety of 6½) at $D/t = 40$ to a stress of 32,500 lb. per sq. in. (a factor of safety of 2) at $D/t = 10$.

It is surprising, indeed, how closely this resembles Stewart's original curve for Grade D material. Perhaps, in view of the long period of practically perfect results that we have had using Stewart's curve (see Fig. 11) with this same type of steel, it may have seemed strange to some that any downward revision was in order. This writer, for one, is beginning to think that our success was not all just good luck, and the downward revision was foisted on us by the injection of a too hurried analysis of the collapse problem.

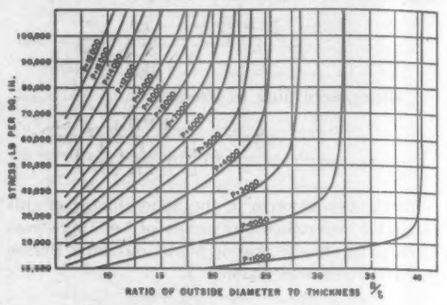


*Fig. 8—Constant-pressure curves*

**Cold working.**

One thing more: If, at any point on the inner surface of the pipe, residual compressive stresses exist, the collapsing forces will search out such spots; and regardless of whether a split ring opens or closes due to the existence of larger stresses located at other points on the inner or outer surface of the pipe, the collapsing strength of the pipe will suffer.

We had hoped to complete our photoelastic studies indicating how unfavorable, localized stresses can exist in a tube that has been cold-worked. They are bound to be present if the shape of the pipe is appreciably out-of-round before cold working, or gets into such a shape during the cold-working process.

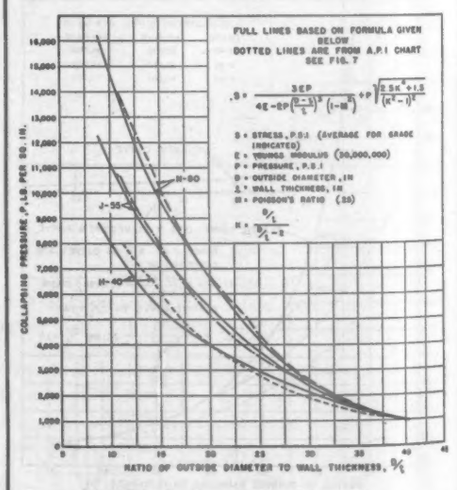
FULL LINES BASED ON FORMULA GIVEN BELOW
DOTTED LINES ARE FROM A.P.I CHART SEE FIG. 7
COLLAPSING PRESSURE, P, LB PER SQ. IN.
RATIO OF OUTSIDE DIAMETER TO WALL THICKNESS, D/t
J-55
H-40
H-50

*Fig. 9—Comparison of curves*

## References

It was not considered necessary, nor even advisable, to go into the detailed derivation of any of the formulas mentioned in this paper. The derivation of the maximum-strain-energy formula for hoop stress can be found in any advanced test on mechanics. The bibliography hereinafter lists the works of Bresse, as well as all the other authors

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mentioned, together with some whose work it did not seem necessary to review in this paper.[9 15]

## Conclusions

In conclusion it is submitted that:

1. Within the range of casing sizes and weights, it is necessary to combine both hoop and bending stresses to get a usable solution to the collapse problem. This paper suggests one method of doing this, using relations already derived. (In fact, some of the work was done nearly 90 years ago.) The equation suggested is complex and cumber-

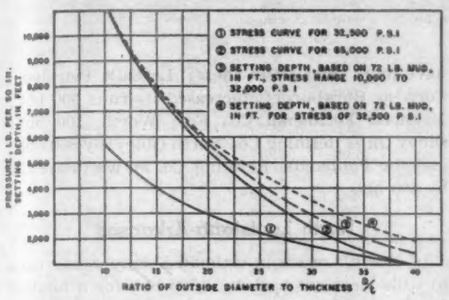
① STRESS CURVE FOR 32,500 P.S.I
② STRESS CURVE FOR 65,000 P.S.I
③ SETTING DEPTH, BASED ON 72 LB. MUD, IN FT., STRESS RANGE 10,000 TO 32,000 P.S.I
④ SETTING DEPTH, BASED ON 72 LB. MUD, IN FT. FOR STRESS OF 32,500 P.S.I
PRESSURE, LB. PER SQ. IN. SETTING DEPTH, IN FEET
RATIO OF OUTSIDE DIAMETER TO THICKNESS D/t

*Fig. 10—Collapse data on A.P.I. Grade J-55*

some; but, by means of graphic solutions, it should not place any burden on the engineers who need to use it.

2. The use of a rational, fairly accurate relation between stress, pressure, and tube proportions makes it possible to predict the effect of residual stresses, and even may make it possible to estimate these residual stresses from the collapse pressure, if the tube proportions and yield strength in compression are known.

3. The use of such a rational, fairly accurate relation between stress, pressure, and tube proportions makes it possible to revise our setting depths; because pressure and stress are not directly in proportion, and half the pressure may (and does in most cases) result in less than half the stress. It is recommended that the setting

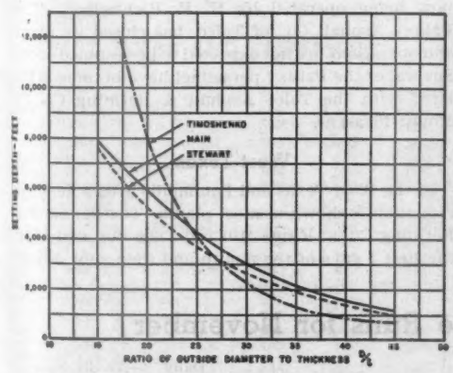


*Fig. 11—Comparison with Stewart's formula*

depth be determined by applying the desired safety factor to the yield stress of the grade of steel in question; that the pressure at this stress be determined; and that this pressure be corrected according to the method outlined in Fig. 10.

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# BOOKS

*TWO STRIKES AND OUT. Edited by William E. McMahon. 156 pp. Garden City, N. Y.: Country Life Press. $1.*

Not baseball, but Mexican confiscation of foreign-owned oil properties, is the subject of this book. The editor of the work was for nearly 20 years a resident of Mexico, the last six of which he was head of the legal department of Huasteca Petroleum Co. The forepart of the book discusses the Mexican background, then launches into a discourse on the American pioneers, labor and politics, and then into the seizure of the oil industry by President Cardenas.


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# First Major Reduction Made in Crude Runs to Mid-Continent Refineries

MID-CONTINENT refiners will reduce crude runs to stills by more than 11,000 bbl. daily during November, according to estimates received early this month. This marks the first substantial reduction in crude runs for many months, the total estimated daily runs being reported as 535,955 bbl. However, the comparable figure for last year was 524,035 bbl.

### Oklahoma

Oklahoma refiners report a reduction of 1,895 bbl. daily with a total of 153,700 bbl. for the month, compared with 155,595 bbl. in October. The Bell Oil & Gas Co., Ben Franklin Refining Co., Black Gold Refining Co., and the Phillips Petroleum Co. plant at Okmulgee all show increases in crude runs but are more than offset by decreases at the following refineries: Cities Service Oil Co., Ponca City, from 9,000 bbl. to 8,300 bbl.; Continental Oil Co., Ponca City, from 21,000 to 19,500 bbl.; Rock Island Refining Co., Beckett, from 6,200 bbl. to 6,000 bbl.; Tide Water Oil Co.'s plant at Drumright, from 12,000 bbl. to 11,000 bbl.; and the Wilcox Refining Co. plant at Bristow which was reduced 500 bbl. daily. The Ben Franklin Refining Co. has just completed its new 1,000-bbl. Dubbs cracking unit. Crude runs were increased by 500 bbl. daily after the new unit was placed on stream.

### Kansas

Kansas refineries again show a slight increase in crude runs. Total estimated daily crude runs for the month are shown as 128,100 bbl. compared with 127,975 bbl. in October. Refineries increasing crude runs and the amount were: Barnsdall at Wichita, 500 bbl.; El Dorado Refining Co., Eldorado, 500 bbl.; Kanotex Refining Co. at Arkansas City, 1,000 bbl.; and the Phillips Petroleum Co. at Kansas City, 675 bbl. The Socony-Vacuum Oil Co. refinery at Augusta reduced its runs by 2,000 bbl. per day.

### North Central Texas

In the North Central Texas area crude runs show an increase of 1,425 bbl. daily, with a total of 38,680 bbl. daily compared with 37,255 bbl. in October. Although several of the smaller plants have cut their crude runs, the following increases have more than offset these: La Salle Petroleum Corp. at Burkburnett increased its runs 300 bbl.; Magnolia Petroleum Co., Fort Worth, 100 bbl.; Olney Oil & Refining Co., North Olney, by 800 bbl.; and the Panhandle Refining Co. at Wichita Falls by 500 bbl.

### North Louisiana-Arkansas

In North Louisiana estimated daily crude runs to stills were cut back by 6,200 bbl. for a total of 40,900 bbl. The Texas Co. plant at Shreveport closed October 23 and will not reopen until next fall. This plant is operated for only a few weeks in the late summer and early fall to fill fuel-oil orders. The revamped plant of the Pennant Refining Co. at Princeton, La., is now on regular operation, running 500 bbl. of Bellevue crude to stills daily, making lubricating oils and some gas oil and asphalt.

Of the six refineries reporting from Arkansas, three of them have lowered crude schedules for November and have reduced the total for the month by 600 bbl. compared with October.

### East Texas

East Texas crude runs have declined 3,600 bbl. in November with the total reported as 44,500 bbl. Reductions were general over the entire area, although increases were made at the Premier, East Texas, Hurricane, and Gladewater plants, the latter now being operated by H. F. Richardson. The Paluxy Asphalt Co., of Talco, has closed its plant and operations are not expected to be resumed soon. Several of the Paluxy personnel have become affiliated with the Talco Asphalt & Refining Co. at Mount Pleasant.

### West Texas

In the West Texas and Panhandle area a general reduction is shown at most plants. The Panhandle Refining Co. at Kings Mill ran 1,400 bbl. daily for the first 7 days of the month and then shut down.

## Mid-Continent Crude Runs

**Average Daily Barrels**

(Advance estimate compiled by The Oil and Gas Journal)

| | 1937 | 1938 | 1939 |
|---|---|---|---|
| January | 531,535 | 529,710 | 503,405 |
| February | 541,790 | 507,985 | 494,910 |
| March | 533,875 | 491,935 | 497,180 |
| April | 558,385 | 532,120 | 523,535 |
| May | 572,855 | 527,315 | 534,535 |
| June | 593,625 | 540,005 | 541,090 |
| July | 605,640 | 557,520 | 550,755 |
| August | 624,475 | 554,810 | 556,095 |
| September | 625,485 | 555,695 | 550,830 |
| October | 619,210 | 531,325 | 547,725 |
| November | 592,170 | 524,035 | 535,955 |
| December | 544,040 | 503,530 | ..... |

### Operations by Refinery Districts

Daily crude runs

| | Nov. | Oct. | Decr. |
|---|---|---|---|
| Arkansas | 27,300 | 27,900 | 600 |
| East Texas | 44,500 | 48,100 | 3,600 |
| Kansas | 128,100 | 127,975 | *125 |
| N. Central Texas | 38,680 | 37,255 | *1,425 |
| North Louisiana | 40,900 | 47,100 | 6,200 |
| Oklahoma | 153,700 | 155,595 | 1,895 |
| Southwest Texas | 17,800 | 18,100 | 300 |
| W. Texas Panhandle | 84,975 | 85,700 | 725 |
| Total | 535,955 | 547,725 | 11,770 |

*Increase.

## Estimated Daily Average Mid-Continent Refinery Crude Runs for November

### OKLAHOMA

| Company and location— | Daily capacity | Av. dly. runs Nov. | Av. dly. runs Oct. |
|---|---|---|---|
| Anderson-Prichard Ref. Corp., Cyril | 8,000 | 6,500 | 6,500 |
| Barnsdall Ref. Corp., Barnsdall | 5,000 | 4,000 | 4,000 |
| Bell Oil & Gas Co., Granfield | 5,000 | 3,000 | 2,660 |
| Ben Franklin Ref. Co., Ardmore | 5,000 | 4,000 | 3,500 |
| Black Gold Ref. Co., Oklahoma City | 2,500 | 2,000 | 1,800 |
| Champlin Ref. Co., Enid | 16,000 | 15,000 | 15,000 |
| Cities Service Oil Co., Okmulgee | 4,000 | (*) | (*) |
| Cities Service Oil Co., Ponca City | 12,000 | 8,300 | 9,000 |
| Continental Oil Co., Ponca City | 28,000 | 19,500 | 21,000 |
| Cushing Ref. & Gasoline Co., Cushing | 4,200 | 3,500 | 3,500 |
| Deep Rock Oil Corp., Cushing | 10,000 | 9,000 | 9,000 |
| Johnson Oil Ref. Co., Cleveland | 6,000 | 5,000 | 5,000 |
| Mid-Continent Pet. Corp., West Tulsa | 35,000 | 21,000 | 21,000 |
| Ohio Oil Co., Bristow | 5,000 | 2,500 | 2,500 |
| Omar Ref. Co., Garber | 5,000 | 2,700 | 2,700 |
| Phillips Pet. Co., Okmulgee | 6,000 | 5,700 | 4,675 |
| Peppers Gasoline Co., Oklahoma City | 500 | 400 | 400 |
| Rock Island Ref. Co., Beckett | 6,500 | 6,000 | 6,200 |
| Sinclair Ref. Co., Sand Springs | 6,000 | 4,500 | 4,500 |
| Sun Oil Co., Yale | 5,000 | 1,500 | 1,500 |
| Sunray Oil Co., Allen | 7,000 | 3,600 | 3,660 |
| Texas Co., West Tulsa | 16,000 | 11,000 | 11,000 |
| Tide Water Oil Co., Drumright | 12,000 | 11,000 | 12,000 |
| Wilcox Ref. Division, Bristow | 5,000 | 4,000 | 4,500 |
| Total | 214,700 | 153,700 | 155,595 |

*Shut down.

### KANSAS

| Company and location— | Daily capacity | Av. dly. runs Nov. | Av. dly. runs Oct. |
|---|---|---|---|
| Anco Ref. Co., Garnett | 500 | 450 | 450 |
| Barnsdall Ref. Co., Wichita | 5,000 | 5,000 | 4,500 |
| Bay Pet. Co., McPherson | 4,000 | 3,000 | 3,000 |
| Chanute Ref. Co., Chanute | 1,000 | 1,000 | 1,000 |
| Derby Oil Co., Wichita | 8,000 | 6,500 | 6,500 |
| El Dorado Ref. Co., Eldorado | 5,000 | 4,500 | 4,000 |
| Falcon Ref. Co., Inc., Great Bend | 1,000 | 1,500 | 1,500 |
| Globe Oil & Ref. Co., McPherson | 15,000 | 15,000 | 15,000 |
| Kanotex Ref. Co., Arkansas City | 12,000 | 7,000 | 6,000 |
| National Ref. Co., Coffeyville | 8,000 | 5,000 | 5,000 |
| Pet. Products Co., Chanute | 1,250 | 1,750 | 1,750 |
| Phillips Pet. Co., Kansas City | 23,000 | 16,000 | 15,325 |
| Roper Pet. Co., Parsons | 750 | 400 | 450 |
| Shallow Water Ref. Co., Scott City | 2,000 | 1,000 | 1,000 |
| Sinclair Ref. Co., Coffeyville | 12,000 | 8,500 | 8,500 |
| Sinclair Ref. Co., Argentine | 11,000 | 8,500 | 8,500 |
| Skelly Oil Co., Eldorado | 23,000 | 20,000 | 20,000 |
| Socony-Vacuum Oil Co., Inc., Augusta | 20,000 | 13,000 | 15,000 |
| Standard Oil Co. (Indiana), Neodesha | 7,500 | 7,000 | 7,000 |
| Vickers Pet. Co., Potwin | 4,000 | 3,000 | 3,500 |
| Total | 164,000 | 128,100 | 127,975 |

*Shut down.

### NORTH LOUISIANA

| Company and location— | Daily capacity | Av. dly. runs Nov. | Av. dly. runs Oct. |
|---|---|---|---|
| Arkansas Fuel Oil Co., Bossier City | 25,000 | 20,000 | 20,000 |
| Atlas Pipe Line Co., Shreveport | 12,500 | 6,000 | 6,000 |
| Bayou State Oil Corp., Hosston | 750 | 600 | 600 |
| East Texas Ref. Co., Sandra | 7,000 | (*) | (*) |
| Pennant Ref. Co., Princeton | 750 | 500 | 500 |
| Premier Oil Ref. Co. of Texas, Cotton Valley | 3,500 | 2,800 | 2,800 |
| Rodessa Oil & Ref. Corp., Cedar Grove | 12,000 | 8,500 | 8,500 |
| Stanolind Oil & Ref. Co., Superior | 5,000 | 2,500 | 2,200 |
| Texas Co., Shreveport | 7,000 | (*) | 6,500 |
| Total | 73,500 | 40,900 | 47,100 |

*Shut down.

### ARKANSAS

| Company and location— | Daily capacity | Av. dly. runs Nov. | Av. dly. runs Oct. |
|---|---|---|---|
| Berry Asphalt Co., Waterloo | 2,000 | 1,100 | 1,300 |
| Henry H. Cross, Smackover | 6,000 | 3,000 | 3,300 |
| Lion Oil Ref. Co., El Dorado | 17,000 | 13,000 | 13,000 |

| Company and location— | Daily capacity | Av. dly. runs— Nov. | Oct. |
|---|---|---|---|
| Macmillan Pet. Corp., Norphlet | 2,500 | 2,000 | 2,000 |
| Root Ref. Co., El Dorado | 10,000 | 8,000 | 8,100 |
| Stephens Ref. Co., Stephens | 700 | 200 | 200 |
| Total | 38,200 | 27,300 | 27,900 |

## NORTH CENTRAL TEXAS

| | | | |
|---|---|---|---|
| Baird Refining Co., Baird | 1,500 | 1,200 | 1,200 |
| Bryson Pipe Line & Refining Co., Bryson | 2,000 | 1,200 | 1,250 |
| Bryson Ref. Co., Inc., Bryson | 1,500 | 800 | 800 |
| Coleman Ref. Co., Coleman | 1,000 | 400 | 400 |
| Continental Oil Co., Wichita Falls | 6,000 | 4,680 | 4,680 |
| Cosden Pet. Corp., Graham | 2,000 | 600 | 600 |
| Falls Ref. Co., Wichita Falls | 2,500 | 500 | 500 |
| Gratex Ref. Co., Graham | 300 | 300 | 300 |
| Gulf Oil Corp., Fort Worth | 8,000 | 6,000 | 6,000 |
| Hightower Oil & Ref. Corp., Brownwood | 750 | (*) | (*) |
| Jacksboro Ref. Co., Jacksboro | 400 | 250 | 250 |
| La Salle Pet. Corp., Burkburnett | 3,000 | 1,300 | 1,000 |
| Magnolia Pet. Co., Fort Worth | 7,500 | 5,300 | 5,200 |
| Muenster Ref. Co., Muenster | 1,800 | 800 | 1,000 |
| North Texas Ref. Co., Gainesville | 600 | 300 | 300 |
| Ohio Oil Co., Fort Worth | 5,000 | 4,000 | 4,000 |
| Olney Oil & Ref. Co., North Olney | 3,500 | 1,800 | 1,000 |
| Paluxy Asphalt Co., Mankins | 1,500 | 1,200 | 1,200 |
| Panhandle Ref. Co., Wichita Falls | 4,200 | 2,500 | 2,000 |
| Panhandle Ref. Co., Luéders | 1,500 | 850 | 875 |
| Taylor Ref. Co., Taylor | 1,000 | 600 | 600 |
| Texas Pacific Coal & Oil Co., Caddo | 800 | 600 | 600 |
| W. T. Waggoner est., Vernon | 6,000 | 3,500 | 3,500 |
| Total | 62,350 | 38,680 | 37,255 |

*Shut down.

## EAST TEXAS

| | | | |
|---|---|---|---|
| Beacon Oil & Ref. Co., Henderson | 4,500 | (*) | (*) |
| Danciger Refs., Inc., Longview | 6,000 | (*) | (*) |
| East Texas Ref. Corp., Longview | 6,000 | 4,400 | 2,500 |
| Gladewater Ref. Co., Gladewater | 3,000 | 2,500 | 1,500 |
| Hurricane Pet. Corp., Overton | 5,000 | 4,000 | 3,700 |
| Hurricane Pet. Corp., Arp. | 3,300 | 2,200 | 2,800 |
| Independent Ref. Co., Arp. | 3,500 | 2,200 | 2,500 |
| Lynch Ref. Co., Kilgore | 3,000 | 2,500 | 2,500 |
| Magnolia Pet. Co., Corsicana | 5,000 | 4,500 | 4,500 |
| McMurrey Ref. Co., Tyler | 10,000 | 3,500 | 4,000 |
| Model Oil & Ref. Co., Kilgore | 2,000 | (*) | 2,500 |
| Paluxy Asphalt Co., Talco | 5,000 | (*) | 2,500 |
| Premier Oil Ref. of Texas, Gregtown | 4,000 | 2,900 | 2,800 |
| Talco Asphalt & Ref. Co., Mount Pleasant | 7,500 | 5,000 | 5,000 |
| Texas Co., Dallas | 16,000 | 8,000 | 8,000 |
| Tower Ref. Co., Overton | 3,500 | (*) | (*) |
| Travis, M. M., Inc., Kilgore | 4,000 | 2,800 | 3,300 |
| Total | 91,300 | 44,500 | 48,100 |

*Shut down.

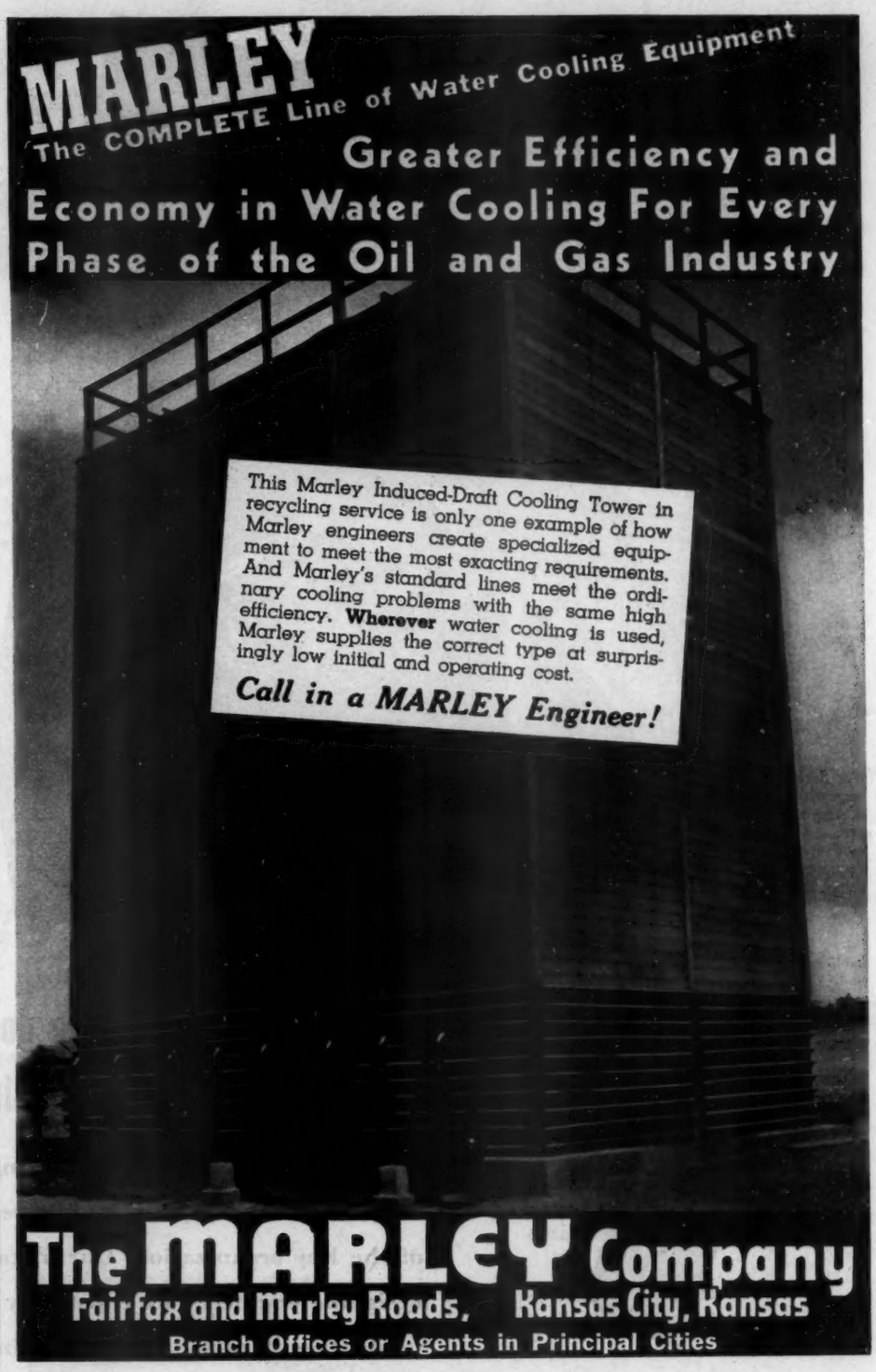
## WEST TEXAS AND PANHANDLE

| | | | |
|---|---|---|---|
| Aero Gas & Ref. Co., Fort Stockton | 350 | 300 | 300 |
| Coltex Ref. Co., Colorado | 12,500 | 8,000 | 8,000 |
| Cosden Oil Co., Big Spring | 12,500 | 11,000 | 11,000 |
| Danciger Refs., Inc., Pampa | 6,500 | 5,000 | 5,500 |
| Danube Oil Corp., Borger | 800 | 400 | 400 |
| Farmers Ref., Lubbock | 500 | 300 | 300 |
| Gulf Oil Corp., Sweetwater | 7,000 | 6,200 | 6,200 |
| Howard County Ref. Co., Big Spring | 2,000 | 1,000 | 1,000 |
| Motor Fuels Corp., Levelland | 4,000 | 2,000 | 2,000 |
| Moutray Oil Co., Hawley | 1,200 | 900 | 950 |
| Onyx Ref. Corp., Hawley | 3,000 | 1,500 | 1,500 |
| Payward Ref. Co., Shamrock | 600 | 475 | 500 |
| Phillips Pet. Co., Borger | 35,000 | 26,700 | 25,800 |
| Post Refining Co., Rotan | 800 | 450 | 500 |
| Shamrock Oil & Gas Corp., Sunray | 3,000 | 2,000 | 2,200 |
| Stamford Ref. Co., Stamford | 450 | 400 | 400 |
| Shamrock Oil & Gas Corp., Lefors | 1,600 | 1,000 | 1,000 |
| Standard Oil Co. of Texas, El Paso | 14,000 | 8,500 | 8,400 |
| Star Light Ref. Co., Ballinger | 1,000 | 500 | 500 |
| Texas Co., El Paso | 2,000 | 1,600 | 1,600 |
| Texas Co., Amarillo | 6,000 | 4,000 | 3,500 |
| Western Ref. Co., Fort Stockton | 1,000 | 750 | 750 |
| Wickett Pet. Co., Wickett | 3,500 | 2,000 | 2,200 |
| Total | 119,300 | 84,975 | 84,500 |

## SOUTHWEST TEXAS

| | | | |
|---|---|---|---|
| Border Oil & Ref. Co., Sullivan City | 1,000 | 500 | 500 |
| Eggleston Oil Products Co., Three Rivers | 1,000 | 1,000 | 1,000 |
| Humble Oil & Ref. Co., San Antonio | 5,000 | 3,500 | 3,500 |
| Magnolia Pet. Co., Luling | 8,000 | 5,000 | 5,200 |
| Pettus Oil & Ref. Co., Pettus | 1,000 | 800 | 900 |
| Phoenix Ref. Co., San Antonio | 2,000 | 1,500 | 1,500 |
| Phoenix Ref. Co., Pettus | 900 | 750 | 750 |
| Pioneer Oil & Ref. Co., Somerset | 2,000 | 750 | 750 |
| Rado Ref. & Prod. Co., McAllen | 800 | 500 | 500 |
| Texas Co., San Antonio | 5,000 | 3,500 | 3,500 |
| Total | 26,700 | 17,800 | 18,100 |

*Shut down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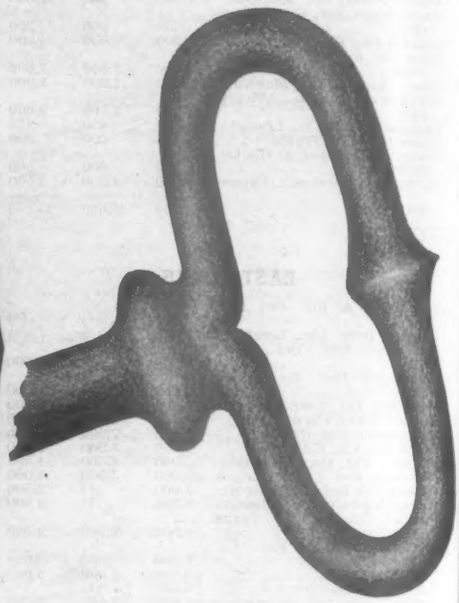

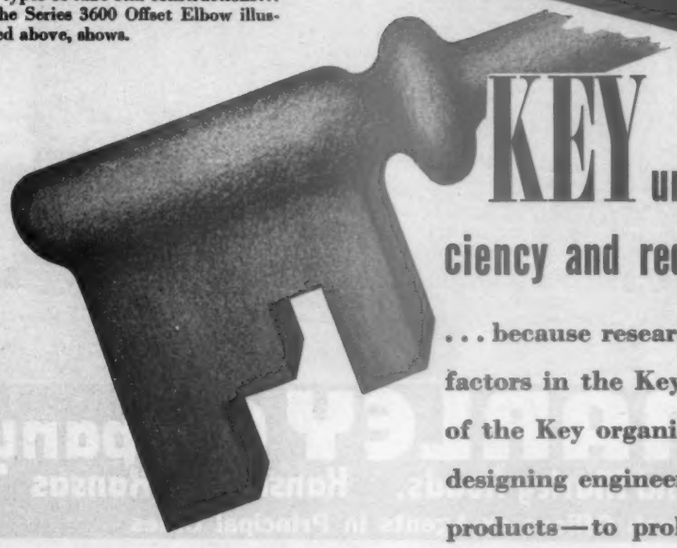

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# FIELD OPERATIONS

## Summarizing the Week's Developments

**KANSAS**—One Barton County wildcat was showing as an Arbuckle-lime discovery, another was near completion as a quartzite pool opener, and a third was completed to open an Arbuckle area. Two discovery wells were completed in Rice County and a gas discovery was completed in Johnson County. The Zenith pool in Stafford County was extended ¼ mile eastward to within ¼ mile of the Reno County line.

**OKLAHOMA**—A Misener-sand well in the Dunn pool, Creek County, flowed 2,350 bbl. of 45-gravity oil in 8 hours. A well on Cement townsite, Caddo County, made daily potential of 5,472 bbl., and a well elsewhere in the pool was completed for potential of 3,362 bbl. Seven operations were started in Section 28-7-4, St. Louis field, Pottawatomie County, after an old well was deepened and found good production in Wilcox sand.

**ILLINOIS**—Devonian-lime production was found in the old Bartelso pool in Clinton County in the 2,400-ft. horizon, the first well starting at 30 bbl. per hour. An important Devonian test in the Salem pool should be completed this week. Illinois production showed a small increase over the previous week.

**TEXAS: Gulf Coast**—A well in East Bay, Galveston County, is a prospective pool opener. A 7,000-ft. wildcat will be drilled on Galveston Island. In eastern Texas a gas and distillate pool was opened in Limestone County. The gas volume was large, with a spray of dark-colored distillate. The Hull-Silk pool in Archer County has a prospective ½-mile extension, and Montague County's Rogers & Rogers pool was extended on the west and south. Wildcats in Duval, Jim Hogg, Starr and Webb counties are showing favorable signs of oil. New sand discoveries and extensions were reported in the North Luby, Victoria and La Rosa fields. The Apco's deep Ordovician pool in Pecos County was cut off on two sides by dry holes but was extended ¼ mile southwesterly.

**LA-ARK-TEX**—Calcasieu Parish in coastal Louisiana has good prospects of a new pool in the 8,900-ft. horizon. The Barataria pool's first well in Jefferson Parish flowed 272 bbl. on its official test. In Columbia County, Arkansas, two wildcats are close to critical depths. In Mississippi two wildcat locations were made in the Tinsley area in Yazoo County. Two wells in the Tinsley field were close to completion. The well north of the discovery well showed salt water at 3,800 ft. and is coring ahead. Interest in the field was not as keen at the week end as it had been earlier in the month.

**MICHIGAN**—A 1,200-bbl. well in Redding Township, Clare County; a 235-bbl. well in the old Wise field in Isabella County, and a 1,200-bbl. well in the Walker pool were the best of last week's results.

## Completions in All Fields

(Week Ended November 11, 1939)

| | Oil | Gas | Dry | Total | 1939 total comp. to date | 1938 total comp. to date |
|---|---|---|---|---|---|---|
| N. Y., Pa., and W. Va. | 48 | 9 | 4 | 61 | 2,797 | 3,106 |
| Ohio | 14 | 9 | 13 | 36 | 890 | 844 |
| Indiana | 7 | 0 | 2 | 9 | 288 | 121 |
| Kentucky | 2 | 1 | 3 | 6 | 603 | 785 |
| Illinois | 59 | 0 | 15 | 74 | 3,115 | 1,665 |
| Michigan | 18 | 1 | 14 | 33 | 1,249 | 805 |
| Kansas | 32 | 4 | 6 | 42 | 1,143 | 1,412 |
| Oklahoma | 11 | 2 | 7 | 20 | 1,499 | 1,497 |
| Texas: | | | | | | |
| North Central Texas | 32 | 0 | 18 | 50 | 2,072 | 2,713 |
| West Texas | 33 | 0 | 5 | 38 | 1,629 | 1,711 |
| Texas Panhandle | 8 | 5 | 0 | 13 | 369 | 495 |
| East Texas | 4 | 0 | 0 | 4 | 353 | 1,587 |
| East Central Texas | 1 | 1 | 1 | 3 | 236 | 305 |
| East Texas Border | 1 | 2 | 0 | 3 | 64 | 120 |
| Gulf Coast Texas | 23 | 0 | 4 | 27 | 1,151 | 1,161 |
| Southwest Texas | 26 | 3 | 15 | 44 | 1,940 | 1,882 |
| Total Texas | 128 | 11 | 43 | 182 | 7,814 | 9,974 |
| North Louisiana | 4 | 3 | 4 | 11 | 451 | 557 |
| Gulf Coast Louisiana | 11 | 0 | 4 | 15 | 582 | 420 |
| Total Louisiana | 15 | 3 | 8 | 26 | 1,033 | 977 |
| Arkansas | 2 | 0 | 0 | 2 | 218 | 214 |
| Montana | 5 | 0 | 0 | 5 | 140 | 95 |
| Wyoming | 3 | 1 | 0 | 4 | 114 | 138 |
| Colorado | 0 | 0 | 0 | 0 | 13 | 11 |
| New Mexico | 12 | 0 | 0 | 12 | 512 | 485 |
| Utah | 0 | 0 | 0 | 0 | 0 | 2 |
| California | 12 | 0 | 1 | 13 | 801 | 1,127 |
| Total United States | 368 | 41 | 116 | 525 | 22,229 | 23,258 |
| Total previous week | 344 | 62 | 122 | 528 | | |
| Week ended Nov. 12, 1938 | 383 | 50 | 102 | 535 | | |

(Week Ended November 11, 1939)

## Outstanding Fields—Highlights

| FIELD— | Rigs up | Wells drlg. | Weekly oil completions | Initial prod. | Total No. oil wells | Daily av. prod. |
|---|---|---|---|---|---|---|
| **TEXAS** | | | | | | |
| K.M.A. | 30 | 42 | 6 | 5,720 | 1,169 | 31,592 |
| Wasson-Bennett | 20 | 85 | 8 | 5,825 | 502 | 14,420 |
| Ector County | 15 | 59 | 9 | 7,102 | 1,911 | 57,450 |
| Pecos County | 5 | 22 | 1 | 198 | 1,208 | 37,996 |
| Jones County | 2 | 19 | 2 | 1,076 | 581 | 8,747 |
| East Texas | 9 | 13 | 4 | 160 | 26,120 | 495,193 |
| **OKLAHOMA** | | | | | | |
| St. Louis | 7 | 24 | 3 | 707 | 902 | 27,400 |
| Cement | 3 | 16 | 1 | *202 | 272 | 5,500 |
| *2-hour flow. | | | | | | |
| **KANSAS** | | | | | | |
| Barton County | 6 | 21 | 5 | 1,917 | 499 | 12,100 |
| Ellis County | 4 | 17 | 4 | 2,074 | 446 | 10,325 |
| Rice County | 8 | 32 | 6 | 1,938 | 1,385 | 28,500 |
| Russell County | 9 | 31 | 10 | 3,143 | 1,352 | 24,175 |
| **NEW MEXICO** | | | | | | |
| Eddy County | 16 | 59 | 1 | 500 | 448 | 12,120 |
| Lea County | 13 | 52 | 11 | 2,170 | 2,294 | 98,120 |
| **LA-ARK-TEX** | | | | | | |
| Magnolia, Ark. | 0 | 9 | 1 | 360 | 72 | 19,485 |
| Cotton Valley, La. (deep) | 0 | 7 | 0 | 0 | 146 | 11,105 |
| **MICHIGAN** | | | | | | |
| Freeman-Redding | 5 | 10 | 2 | 1,229 | 125 | 14,595 |
| Kent County | 9 | 55 | 9 | 2,913 | 187 | 11,346 |
| **CALIFORNIA** | | | | | | |
| Wilmington | 4 | 12 | 2 | 1,065 | 729 | 86,750 |
| **ILLINOIS** | | | | | | |
| Salem | 9 | 90 | 19 | 1,892 | 1,409 | 179,178 |
| Louden | 10 | 89 | 16 | 6,949 | 1,199 | 68,922 |
| Other basin fields | 40 | 260 | 24 | 3,707 | 3,657 | 71,758 |
| Old fields | .... | ..... | .... | ..... | ..... | 8,301 |

# Illinois, Indiana and Kentucky

By STAFF CORRESPONDENT

# Devonian Pool in Bartelso Is Illinois' Feature Event

CENTRALIA, Ill., Nov. 13.—Production in Illinois increased 2,379 bbl., or to 328,959 bbl. per day in the past week. Salem was credited with 179,178 bbl.; Louden with 68,922 bbl., an increase from Louden's previous week's figure of 65,079 bbl.

Fifty-nine oil wells were completed in the state during the week and 15 dry holes. The failures were one each in Fayette, Clark, Monroe, Wabash, Perry, Williamson and Johnon counties and two each in Lawrence, Marion, Jefferson and White counties.

Louden field had 16 new oil wells with 6,949 bbl. initial production; St. James pool, 1 well, 107 bbl. The new Fairman pool in Marion County, 1 well, 156 bbl.; Salem pool, 19 wells, 1,892 bbl., the initial production time varying from 1 hour to 24 hours; Jefferson County, 2 wells, 115 bbl.; Clay, 3 wells, 1,148 bbl.; Wabash, 9 wells, 1,533 bbl.; Washington, 3 wells, 79 bbl.; White, 3 wells, 456 bbl.; Gallatin, 1 well, 93 bbl.; total new oil wells, 59, total initial production 12,548 bbl.

A Devonian-lime production discovered in the Bartelso field in Clinton County was one of the important events of the past week. Paul Moseback and others' No. 1-B Robbin, SW SE SE Section 5-1n-3w, found the lime pay at 2,421-31 ft., and the well started flowing 30 bbl. per hour. Production in the other wells in the Bartelso pool is coming from Cypress sand. Town-lot leases in Bartelso were selling at around $20 a lot since the well came in.

The Kingwood Oil Co.'s Devonian test in the Salem field found the lime at 3,345 ft. and drilled to 3,502 ft. It was decided to complete the well with cable tools. Casing was set and the plug will be drilled some time this week. The well is in Section 20-2n-2e. This well is a somewhat disturbing factor, inasmuch as it may cause an extensive Devonian-lime play in the Salem field if it comes in a large producer.

A large gas well, estimated from 20,000,000 to 30,000,000 cu. ft. per day was completed in White County in Tatum's No. 1 Auld in Section 23-6s-9e, in Waltersburg sand at 2,244-54 ft. Angle & Eason's No. 2 Storms in Section 6-6s-9e, was reported to be good for 600 bbl. of oil per day from Waltersburg sand topped at 2,240 ft.

There were 93 new operations in the state during the week.

## Completed Wells

The completion report in detail, with initial production representing 24 hours, unless otherwise stated, is as follows:

### Fayette County

In the Louden field in Fayette County Carter Oil Co.'s No. 1 Huffman, SW SE NE Section 2-8n-3e, shot with 10 qt. at 1,603-06 ft. and acidized with 1,000 gal. and shot with 30 qt. at 1,532-44 ft., swabbed 318 bbl. through casing. Carter's No. 9 Tom Wright, NE SW SE Section 20-8n-3e, shot with 10 qt. at 1,560-63 ft. and with 10 qt. at 1,461-64 ft., swabbed 216 bbl. through casing. Carter's No. 1 Dial, SW SE NE Section 28-8n-3e, total depth 1,588 ft., plugged back to 1,547 ft. and shot with 40 qt. at 1,515-47 ft., flowed 1,056 bbl. of oil. Carter's No. 8 Mills, SE SW SE Section 28-8n-8e, shot with 10 qt. at 1,579-82 ft., and with 30 qt. at 1,527-37 ft., swabbed 1,000 bbl. through casing, producing from Paint Creek and Bethel sands. Jarvis' No. 17 Sinclair, SW NW NE Section 29-8n-3e, shot with 20 qt. in Bethel sand and 1,495-1,510 ft., pumped 140 bbl. Carter Oil Co.'s No. 6 L. Cummings, NW NE SW Section 32-8n-3e, shot with 40, 10, and 40 qt. at 1,527-40 ft., flowed 690 bbl. Carter's No. 9 Cummings, SE SW NW Section 32-8n-3e, shot with 60 qt. at 1,559-78 ft. and with 40 qt. at 1,534-47 ft., flowed 714 bbl. Carter's No. 15 Ireland, total depth 1,574 ft., shot with 20 and 10 qt., flowed 516 bbl. Carter's No. 8 Tirrey, NE NE SW Section 32-8n-3e, shot with 60 qt. at 1,530-53 ft., and with 20 qt. at 1,513-20 ft., flowed 570 bbl. Carter's No. 6 Dial, NE NW NE Section 33-8n-3e, Cypress sand at 1,453-1,500 ft., shot with 30 qt., at 1,490-1,500 ft., swabbed 318 bbl. Stewart's No. 5 McCoy, NW SE NE Section 34-8n-3e, total depth 1,591 ft., pumped 15 bbl. of oil and 10 bbl. of water. Carter's No. 10 H. Welker, SW SW SE Section 7-7n-3e, shot with 10 qt., total depth 1,577 ft., swabbed 140 bbl. Carter's No. 7 McCormick, shot with 60 qt. at 1,478-1,508 ft., swabbed 208 bbl.

Robert Markham and others' No. 1 Logue, NW NE SW Section 18-7n-3e, dry and abandoned at 1,649 ft., Paint Creek sand penetrated at 1,605-10 ft. Carter Oil Co.'s No. 9 I. Hobbs, SE SE NE Section 6-7n-3e, total depth 1,561 ft., shot twice with 15 qt., swabbed 120 bbl. Carter's No. 13 Hobbs, SE NW NE Section 6-7n-3e, total depth 1,578 ft., shot with 40 and 30 qt., swabbed 484 bbl. Carter's No. 7 Deal, SE NE NW Section 6-7n-3e, shot with 60 qt. at 1,478-97 ft., swabbed 444 bbl. through casing.

In the St. James area, Fayette County, Ohio Oil Co.'s No. 2 J. Kistler, CWL NW¼ Section 31-6n-3e, pumped 107 bbl., total depth 1,613 ft.

In Bond County Bond Oil Co. deepened No. 1 Dresser, SW cor. NW NE NW Section 21-6n-4w, from 1,842 ft. to pay at 1,848½-49 ft., total depth. The well pumped 20 bbl. in 8 hours with a small quantity of water. The well did not pump off. The owners pump it 8 hours a day and then shut down.

In Clark County George B. Scherritt's No. 1 Turner, SE SE NW Section 14-11n-14w, dry and abandoned at 860 ft.

In Lawrence County Walter Payne's No. 1 Patrick Brothers, NW cor. SW NE Section 28-4n-11w, dry and abandoned in Kirkwood sand at 1,545-81 ft., total depth 2,520 ft. Hugill's No. 1 Malone, 100 ft. from north and 500 ft. from west lines of NE¼ Section 21-3n-14w, had Fredonia lime at 3,170 to 3,243 ft. It was dry and abandoned.

### Marion County

In a new pool discovered by Shell Oil Co., Inc.'s No. 1 Lutz, NW NW SE Section 18-3n-1e, between the Sandoval and Patoka pools in Marion County, the discovery well, topped Benoist sand at 1,429 ft., and was shot with 3½ qt. at 1,433-37 ft. It produced 156 bbl. of oil and 39 bbl. of water in 24 hours. The hole had been drilled to 1,442 ft. and plugged back to 1,439 ft. Southeast of it in C SW SW Section 20-3n-1e, Centralia Refining Co.'s No. 1 Henning had no showing of oil in Benoist sand at 1,559 ft., total depth 1,580 ft., and was abandoned. These wells were recorded in a previous issue.

In the Sandoval field in Marion County Kingwood Oil Co.'s No. 1 Konrad, in Section 8-2n-1e, was completed at 1,500 ft. as a salt-water-disposal well.

In the Salem field in Marion County Ohio Oil Co.'s No. 14 M. J. Young, SW cor. SE NW Section 20-2n-2e, had Benoist top at 1,793 ft. and Aux Vases top at 1,839 ft., total depth 1,865 ft. It was shot with 60 qt. at 1,806-60 ft. and flowed 40 bbl. in 2 hours. Ohio's No. 23 M. Young heirs, NW NE SW Section 20-2n-2e, McClosky lime at 1,972-80 ft. and 2,004-30 ft., flowed 297 bbl. naturally in 12 hours. Ohio's No. 27 Lloyd, SW NW NE Section 33-2n-2e, McClosky at 1,986-2,002 ft. and 2,040-58 ft., acidized with 3,000 gal., pumped 75 bbl. Ohio's No. 24 M. Young heirs, NW NE SW Section 20-2n-2e, shot with 60 qt. in Benoist sand at 1,796-1,817 ft., flowed 353 bbl. in 16 hours. Ohio's No. 26 M. Young heirs, NE NW SW Section 20-2n-2e, McClosky lime at intervals from 2,019 to 2,075 ft., acidized with 3,000 gal., flowed 350 bbl. in 20 hours. Shell Oil Co., Inc.'s No. 10 Salem State Bank, NE NW SE Section 20-2n-2e, shot with 25 qt. at 1,840-58 ft., Aux Vases sand, pumped 110 bbl. Texas Co.'s No. 2 Sweney, SE SW NW Section 20-2n-2e, Benoist sand at 1,849-77 ft., pumped 28 bbl. in 3 hours, rated at 196 bbl. per day. Texas' No. 3 Sweney, NE SW NW Section 20-2n-2e, McClosky pays at 2,033-2,106 ft., pumped 33 bbl. in 3 hours, rated at 231 bbl. per day. Texas' No. 5 N. Shanafelt, SE NW NE Section 21-2n-2e, McClosky pays at 2,065-97 ft., flowed 30 bbl. in 3 hours, rated at 210 bbl. per day. Texas' No. 11 Frederick, NW SW NW Section 29-2n-2e, shot in Benoist sand at 1,853-63 ft., flowed 33 bbl. in 3 hours, rated at 231 bbl. per day. Texas' No. 3 W. Frederich A, NE NW SW Section 29-2n-2e, McClosky lime at 1,920-55 ft., flowed 22 bbl. in 3 hours, rated at 154 bbl. per day. Texas' No. 17 Frederich A, McClosky at 1,930-56 ft., flowed 36 bbl. in 3 hours, rated at 252 bbl. per day. Texas' No. 4 L. Maxwell B, SE NE SE Section 30-2n-2e, McClosky at 1,940-53 ft. and 1,970-80 ft., flowed 70 bbl. in 3 hours, rated at 490 bbl. per day. Texas' No. 9 Wayman, C S½ NE NE Section 31-2n-2e, McClosky pay streaks at 1,926-70 ft., flowed 195 bbl. in 3 hours, rated at 1,365 bbl. per day. Texas' No. 10 K. Wayman, C W½ SW NE Section 31-2n-2e, McClosky top at 1,909 ft., total depth 1,990 ft., flowed 102 bbl. in 3 hours, rated at 714 bbl. per day.

Bialock & Thorp's No. 1 Robinson, NE cor. NW SE SE Section 8-2n-1e, in the Sandoval field, Devonian lime at 3,080 ft., total depth 3,133 ft., dry and abandoned.

In the north end of the Salem field in Marion County, Texas Co.'s No. 22 L. Hawthorne, SE SW NE Section 8-1n-2e, McClosky pays at 2,048-77 ft., acidized with 2,000 gal., pumped 12 bbl. in 3 hours, rated at 84 bbl. per day. Texas' No. 37, city of Centralia land, SE SW NW Section 4-1n-2e, Benoist top at 1,811 ft., Renault at 1,906 ft., pumped 30 bbl. in 3 hours, rated at 210 bbl. per day. Texas' No. 36 City of Centralia, NE NW SW Section 4-1n-2e, Benoist sand at 1,817 ft., total depth 1,901 ft., pumped 58 bbl. in 3 hours, rated at 406 bbl. per day. Texas Co.'s No. 7 W. D. Fyke, NW NE SE Section 8-1n-2e, McClosky pays at 2,055-77 ft., flowed 18 bbl. in 3 hours, rated at 126 bbl. per day.

### Jefferson County

In Jefferson County Magnolia Petroleum Co.'s No. 2 Stonecipher, NE SE NE Section 9-1s-1e, Cravat pool, Benoist at 2,071-76 ft., pumped 80 bbl. per day. S. M. McGee's No. 1 E. E. Holloway, NW NW NE Section 10-1s-1e, dry and abandoned at 2,113 ft., Benoist sand at 2,100 ft. contained water. Lickey and others' No. 1 Brownwood, SE NW NW Section 9-1s-1e, dry and abandoned in McClosky lime at 2,330-56 ft., which contained only water. Carter Oil Co.'s No. 2 V. Hawkins, NW NW SE Section 9-1s-2e, Dix pool, Bethel sand at 1,933-39 ft., shot with 10 qt., pumped 35 bbl.

In Monroe County Charles T. Judd's No. 1 Kohmar, NW cor. SE NE Section 24-2s-10w, dry and abandoned at 576 ft.

### Clay County

In Clay County Orchard Oil Co.'s No. 3 Norton, SW NW NW Section 18-2n-8e, 5½-in. casing set at 3,006 ft., total depth 3,029 ft., 700 bbl. per day, natural flow. Pure Oil Co.'s No. 4 A. G. Smith A, C SW NW Section 7-2n-8e, set 5½-in. casing at 3,035 ft., total depth 3,057 ft. (plugged back from 3,152 ft.), acidized with 5,000 gal., flowed 248 bbl. Pure Oil Co.'s No. 1 Hubbis, C E½ NE NW Section 33-2n-8e, Fredonia pay at 3,020-22 ft. and 3,070-73 ft., acidized with 5,000 gal., flowed 200 bbl.

In Wabash County Centralia Refining Co.'s No. 1 Lovelette, SW SE SW Section 9-2s-13w, Keensburg pool, Cypress sand at 2,444-58 ft., shot with 5 qt., pumped 31 bbl. Kingwood Oil Co.'s No. 2 Bump, SW SE NW Section 9-2s-13w, Cypress sand at 2,406-27 ft., shot with 30 qt. on bottom, pumped 382 bbl. Melvin's No. 1 George Beard, NE SE SW Section 9-2s-13w, Cypress sand at 2,434-55 ft., swabbed 65 bbl. Pearson's No. 1

Mary Watkins, SW NE SW Section 9-2s-13w, Cypress sand at 2,424-44 ft., swabbed 100 bbl. G. R. Yount's No. 1 Epler, SE NE SW Section 9-2s-13w, shot with 20 qt. at 2,432-41 ft., Cypress sand, pumped 150 bbl. Zephyr Drilling Co.'s No. 1 Cowling, SE NW SW Section 17-2s-13w, Cypress sand at 2,460-73 ft., flowed 420 bbl. in 20 hours. Olin & Hayes' No. 2 Gray, NE cor. SE NE NE Section 17-2s-13w (corrected location), North Griffin pool, Cypress sand at 2,400-16 ft., shot with 10 qt. on bottom, pumped 45 bbl. Harry Reckas' No. 1 Elkins, NW cor NE¼ Section 29-2s-13w, Cypress sand at 2,483-91 ft., shot with 10 qt., swabbed 18 bbl. Continental Oil Co.'s No. 2 Gray, NE NE NE Section 30-2s-13w, Cypress sand at 2,467-85 ft., pumped 110 bbl. Dallas Hawkins' No. 1 Cowling, SE NE SE Section 18-2s-13w, dry and abandoned at 2,808 ft. McClosky lime at 2,800 ft. contained only water.

### Washington County

In Washington County Ohio Oil Co.'s No. 2 Miller, SE NE SE Section 22-3s-3w, Benoist at 1,265-91 ft., pumped 35 bbl. of fluid, 15 per cent water. Shell Oil Co., Inc.'s No. 7 Kozuszek, NW SW NW Section 23-3s-3w, Cordio pool, Benoist at 1,261-92 ft., shot with 26 qt., pumped 24 bbl. in 21 hours. Magnolia Petroleum Co.'s No. 10 Kurwicki, NE NE NE Section 22-3s-3w, Benoist sand at 1,262-75 ft., shot with 25 qt., pumped 25 bbl.

### White County

In White County H. H. Weinert, Inc.'s No. 1 Newby, SE SE NW Section 31-3s-8e, Mill Shoals pool, McClosky lime at 2,265-78 ft., acidized with 1,000 gal., pumped 46 bbl. of oil and 3 bbl. of water. Nation Oil Co.'s No. 3 Hammack, SE SW SE Section 31-3s-8e, shot with 20 qt. at 3,235-60 ft., pumped 13½ bbl. of oil and 2½ bbl. of water in 12 hours and pumped off. Lackey & Wilson's No. 1 Rawlins, NW NW SE Section 6-4s-8e, was junked and abandoned at 3,438 ft. McClosky lime was topped at 3,350 ft.

In Perry County L. C. Simmell's No. 1 Kimsey, NE NE NW Section 13-5s-2w, was dry and abandoned at 1,582 ft. Fredonia lime was topped at 1,551 ft.

In White County Continental Oil Co.'s No. 1 Hanna, SE SE NW Section 28-5s-10e, McClosky lime at 3,090-3,143 ft., contained water and was abandoned. Penn.-Ill Oil Co.'s No. 2 Porter, C W½ NE SE Section 12-6s-8e, pays at intervals from 3,091 to 3,138 ft., flowed 396 bbl. in 24 hours.

In Gallatin County Zappa & Green's No. 4 Green, NW SW SW Section 16-9s-9e, shot with 60 qt. at 1,780-1,804 ft., pumped 93 bbl. in 19 hours.

In Williamson County Adams & Doran's No. 1 Moore, SE NE NE Section 4-10s-3e, Fredonia lime top at 2,376 ft., total depth 2,462 ft., dry and abandoned.

In Johnson County Coates and others' No. 1 Albright, NE NW SE Section 22-12s-2e, dry and abandoned at 1,747 ft., Salem lime at 1,680-95 ft.

### New Wildcat Operations

In Montgomery County Henderson Brothers' No. 1 Ostermeier, NW NW NW Section 30-10n-4w, spudded.

In Shelby County E. J. Boesche, Jr., and others' No. 1 Bigler, NW NE NW Section 12-9n-6e, moving in rotary.

In Effingham County Kingwood Oil Co.'s No. 1 Reichelm, 340 ft. from north and 610 ft. from east lines of NE¼ Section 21-6n-6e, moving in materials.

In Clay County Dick Burnett's No. 1 Smith, NE cor. SW¼ Section 21-5n-5e, spudded.

In Bond County No. 1 Albert Wade, 70 ft. from south and 1,758 ft. from west lines of SW¼ Section 16-6n-4w, rig up.

In Wabash County Paxton H. Gray's No. 1 Zimmerman, SW SW SE Section 36-1n-13w, rig up. Chet Evarts' No. 1 Trapp, SE NE NE Section 6-1s-12w, set 10-in. casing at 110 ft. Lowell & Ford's No. 1 Meyer, NE NE NW Section 4-1s-13w, location.

In Monroe County Morris and others' No. 1 Gummerschimer, W½ SW NW NW Section 31-1n-10w, spudded and shut down.

In Edwards County Harry Thorpe and others' No. 1 Broster, NW SE NW Section 33-1s-14w, moving in rotary tools.

In Wayne County W. R. Curry and others' No. 1 Felix, NW NW NW Section 20-3s-8e, drilling at 350 ft.

In Washington County Shell Oil Co., Inc.'s No. 1 Dix, NW NE NE Section 19-3s-1w, drilling at 316 ft.

In Jefferson County Magnolia Petroleum Co.'s No. 1 Brown, NW SW NE Section 22-3s-2e, rig up.

In White County Vance Ford and others' No. 1 Spencer, NE NE NE Section 2-5s-10e, location. Burr Lambert and others' No. 1 Batsch, NE NW NW Section 6-5s-10e, moving in rotary tools.

## EASTERN KENTUCKY

ASHLAND, Ky., Nov. 10.—In Magoffin County Rough River Corp. is down 857 ft. in No. 2 on the Elkhorn Coal Corp. tract No. 1825 on Short Fork in the Burning Fork district.

In Floyd County Kentucky-West Virginia Gas Co. was drilling at 1,925 ft. in lime in No. 5258 George McKinney land on Toler Creek and is drilling at 950 ft. in slate in No. 5259 on the John W. Taylor land, also on Toler Creek.

Keathley Allen & Hale have passed the 1,520-ft. level in No. 1 on the Thomas Jervis land on Home Branch.

In Martin County Kentucky-West Virginia Gas Co. has reached the 140-ft. mark in lime in No. 581 on the Wilson Short land and is near the 590-ft. level in No. 5257 on the R. S. Stafford land on Rockcastle Fork.

In Knott County Inland Gas Corp. has reached the 2,685-ft. mark in Brown shale in No. 211 on the W. H. Smith land on Cave Branch of Troublesome Creek.

In Lawrence County Big Blaine Oil Co. is still setting rig at No. 1 on the W. N. Savage farm in the Busseyville-Fallsburg district.

## WESTERN KENTUCKY

OWENSBORO, Ky., Nov. 13.—A 110-bbl. well producing from Barlow and Bethel sands was the best the western Kentucky fields had to offer in the past week during which two oil wells, three dry holes, and a gas well were completed. Following is the record of completions and new work started:

Butler County, Mount Zion School district, South Penn Oil Co.'s No. 1 E. R. McPherson, dry hole at 879 ft.; No. 2 McPherson, spudding in.

Daviess County, Cane Run School district, J. C. Ellis and Huff's No. 1 R. Ambrose, dry hole at 1,265 ft.; old well drilled deeper. F. F. Gibson and others' No. 3 Mrs. Laura V. Howard, rigging up; Cane Run Petroleum Co.'s No. 14 R. E. Jackson, drilling at 150 ft. Three miles northwest of Owensboro, M. P. Evans and others' No. 1 Sam Ewing, set 130 ft. of 7-in. casing; waiting for cement to set. Utica district, Stewart, Snyder and Sargent's No. 3 Roy Hansford, spudding in; Baldwin Oil Co.'s No. 1 W. D. Igleheart, filled up 1,300 ft. with oil after the shot. Estimated at 110 bbl. per day, from Barlow and Bethel sands. Total depth is 1,465 ft. J. C. Ellis' No. 3 J. C. Ellis, filled up 6 ft. with oil after drilling 6 in. into McClosky lime at 1,740 ft. Wanna Oil Co.'s No. 1, L. & N. Railroad right-of-way, rigging up. Maceo district, Hart & Hart's No. 1 Mrs. May Haywood, dry hole at 1,175 ft.

Hancock County, Cloverport district, Lincoln Petroleum Co.'s No. 2 C. A. Johnson, rigging up.

Henderson County, Spottsville district, Magnolia Petroleum Co.'s No. 1 Boyd heirs, 5 ft. of McClosky saturation, total depth 2,258 ft., waiting for cement.

Ohio County, Sunnydale district, Tuttle and Russling's No. 5 Lena Berry, 10-bbl. well from upper Pennsylvanian sand, total depth 158 ft. Pleasant Grove Church district, Owsley's No. 1 Davidson heirs, drilling at 300 ft.

## OHIO FIELDS

NEWARK, Ohio, Nov. 13.—Twenty-four wells were completed in the Ohio fields covered by this report: nine gas wells, four oil wells and ten dry holes. Cuyahoga County yielded a fair gas well making better than 3,000,000 cu. ft. A wildcat test in Lake County found the Clinton sand dry. The completions follow:

Athens County, Lodi Township, Ohio Fuel Gas Co.'s No. 2 Genevia Mansfield, Section 6, gaged 112,000 cu. ft., open flow, from second Berea sand at 1,608 ft.; in Section 13, Ross, Weimer & Ross' No. 7 G. P. Ackly made 3 bbl. of oil the first day from first Cow Run sand at 420-25 ft. The well was not shot.

Mayfield Village, Cuyahoga County, Benedum-Trees, Inc.'s No. 1 C. B. Ward, Lot 20, topped the Corniferous at 1,578 ft. and has 3,200,000 cu. ft. of gas from Newberg sand at 2,866 ft.

Guernsey County, Center Township, Frank Stranges' No. 1 R. K. Warne, Section 14, had a small gas showing in the Berea and was abandoned at 1,248 ft. Mill-

*(Continued on Page 239)*

# Indiana Pools Had No Big Wells in Last Week's Crop

EVANSVILLE, Ind., Nov. 13.—No wells of large production were completed in the new fields of Indiana in the past week. Seven oil wells and two dry holes comprised the week's harvest of wells.

In Gibson County Lewis Production Co.'s No. 3 Cooper C, NW SE NW Section 24-3s-14w, Griffin pool, total depth 2,524 ft., pumped 120 bbl. of oil and 30 bbl. of water in 22 hours. Lewis Production Co.'s No. 5 Cooper D, NE NE NW Section 13-3s-14w, sand at 2,123-29 ft., 85 bbl. the first 14 hours. Hollandsworth & Bander's No. 22 Cooper, SE cor. NW NW NW Section 19-3s-13w, sand at 2,063-86 ft., shot with 17 qt., pumped 35 bbl. Hollandsworth & Bander's No. 19 Cooper, NW cor. Section 19-3s-13w, shot with 20 qt. at 2,512-28 ft., and ripped pipe at 2,062-92 ft., pumped 38 bbl. the first 24 hours.

In Posey County Roberts Brothers' No. 2 Keck, NE NW NW Section 34-3s-14w, Ste. Genevieve lime top at 2,808 ft., total depth 2,916 ft., dry and abandoned. Superior Oil Co.'s No. 12 New Harmony land, sand at 2,158-70 ft., flowed 75 bbl. in 24 hours through ¾-in. choke. Superior Oil Co.'s No. 10 New Harmony, SW SE SW Section 10-5s-14w, removable pipe drilled out at 2,201-11 ft., flowed 75 bbl. through ¾-in. choke.

In Harrison County Stoll Oil Refining Co.'s No. 1 Greer, SW cor. NW NW SW Section 25-5s-4e, dry and abandoned at 716 ft.

In Spencer County Damron Brothers' No. 1 Howard, SW SE SE Section 35-7s-7w, Aux Vases sand at 1,519-30 ft., shot with 20 qt., pumped 7 bbl. of water and 15 bbl. of oil. Kelly and others' No. 1 Niles, SE SW SE Section 35-7s-7w, acidized with 5,000 gal. at 1,547-1,654 ft., pumped about 5 bbl. of oil and considerable water.

In Vermilion County W. F. Ridenour has rig up for No. 1 Earl Brothers, SW SE SW Section 22-15n-9w.

In Vigo County Ben Nation was drilling at 1,500 ft. in No. 1 Boyll, SE SE SW Section 33-11n-9w. Siosi's No. 1 Stufflebeam, C N½ NW SE Section 16-10n-10w, topped Mississippi lime at 1,007 ft., and was drilling at 1,550 ft.

In Clay County Dorsey Oil Co.'s No. 1 Hickman, NW SE SE Section 15-9n-6w, drilling at 300 ft.

In Sullivan County Niagaran Oil Co.'s No. 1 Knowles, SE SE NW Section 6-8n-9w, drilling at 857 ft. E. L. Shandy and others had machine in for No. 2 Osburn heirs, NE cor. NE SW SE Section 12-8n-10w. Siosi's No. 1 Cushman, NE NE SE Section 18-8n-10w, had a small showing of gas at 1,464-67 ft., and was drilling at 1,497 ft.

In Knox County Michel Brothers were drilling at 550 ft. in No. 1 Schloot, SE SE SE Section 2-5n-7w. M. I. T. Syndicate's No. 1 Keith, SW SW SW Section 5-5n-9w, drilling at 935 ft. M. I. T. Syndicate's No. 1 McHenry, Donation 214, Township 5n-9w, drilling at 2,663 ft.

In Martin County Newton Pipe Line Co.'s No. 1 Hiatt, NE NE SE Section 36-4n-5w, Big lime at 342 ft., drilling at 350 ft.

In Daviess County Ruble's No. 1 Huff, NW SE NW Section 9-2n-9w, Barlow sand at 483 ft., drilling at 607 ft. D. L. Morris' No. 1 Daviess County Land Co., hole full of water at 570 ft., had an estimated 500,000 cu. ft. of gas at 557-65 ft., and a small showing of oil at 565-70 ft.

In Knox County Newton Pipe Line Co.'s No. 1 Like C E½ NE Donation 171, Township 2n-9w, Ste. Genevieve lime at 1,415 ft., drilling at 1,465 ft. Fred L. Hartman's No. 1 White, NW cor. NW SW Section 22-2n-7w, drilling at 1,272 ft., with a small showing of oil at 1,262-65 ft.

# Oklahoma Operations

By DAL DALRYMPLE

# New Misener Well, Dunn Pool, Flows 2,350 Bbl. in 38 Hours

New wells in old areas featured field activity in Oklahoma the past week, with the Dunn pool in southern Creek County, the old St. Louis field in Pottawatomie County and the older Cement field in Caddo County yielding important producers.

W. M. Dunn and associates proved the new productive spot they opened in southeastern Creek County several months ago was no fluke when they brought in the No. 2 Cantrell, SW NE SE Section 34-14-10, last week for big production in Misener sand. It topped the sand at 3,173 ft. and was bottomed at 3,181 ft., the pay being found about 12 ft. higher than in the discovery well. On initial test it flowed 2,350 bbl. of oil in 38 hours, when it was shutin and will be prorated. On this showing it rates as one of the larger Misener sand wells in the state. Gravity of the oil was 45 degrees.

## Estimated Daily Production

Estimated daily production for Oklahoma for the week ended November 11, and for the preceding week was as follows:

| | Barrels | |
|---|---|---|
| | Nov. 11 | Nov. 4 |
| Allen | 5,850 | 5,900 |
| Billings | 6,150 | 6,175 |
| Burbank | 7,275 | 7,225 |
| South Burbank | 9,300 | 9,350 |
| Balance Osage | 17,500 | 17,800 |
| Blackwell district | 3,575 | 3,550 |
| Bristow-Slick | 6,425 | 6,450 |
| Chandler | 1,475 | 1,450 |
| Crescent | 2,625 | 2,650 |
| Cromwell | 3,025 | 3,050 |
| Cushing-Shamrock | 9,325 | 9,325 |
| Duncan | 3,775 | 3,825 |
| Edmond | 4,450 | 4,475 |
| Fish | 4,075 | 4,025 |
| Fitts | 22,725 | 21,500 |
| Jesse | 2,175 | 2,225 |
| Graham-Fox | 2,825 | 2,875 |
| Gray | 775 | 750 |
| Healdton | 9,525 | 9,550 |
| Hewitt | 3,925 | 3,900 |
| Keokuk | 3,475 | 3,450 |
| Konawa | 1,125 | 1,100 |
| Lucien | 8,350 | 8,350 |
| Moore | 2,850 | 2,875 |
| Oklahoma City | 105,900 | 87,275 |
| Olympic | 2,625 | 2,675 |
| Ramsey | 4,850 | 4,875 |
| Sasakwa | 1,650 | 1,675 |
| Sholem-Alechem | 2,700 | 2,725 |
| Seminole district: | | |
| Bowlegs | 7,050 | 7,025 |
| Carr City | 2,325 | 2,300 |
| Dora | 2,925 | 2,975 |
| Earlsboro | 4,175 | 4,275 |
| South Earlsboro | 525 | 525 |
| East Earlsboro | 2,650 | 2,625 |
| Little River | 6,125 | 6,175 |
| East Little River | 750 | 750 |
| Maud | 625 | 625 |
| Mission | 1,225 | 1,275 |
| Seminole | 6,775 | 6,750 |
| East Seminole | 1,125 | 1,150 |
| Searight | 2,100 | 2,150 |
| Total Seminole | 38,375 | 38,600 |
| St. Louis-Pearson | 27,400 | 31,150 |
| Tatums | 1,925 | 1,950 |
| Tonkawa-Garber-Thomas | 3,925 | 3,925 |
| Wewoka | 1,675 | 1,725 |
| Yale-Jennings | 3,350 | 3,375 |
| Other pools | 92,575 | 93,275 |
| Total Oklahoma | 429,525 | 415,050 |

It is the fifth producer in the Dunn pool and is the north offset to the operators' discovery well, No. 1 Cantrell. The operators completed their second well in the pool at No. 1 Anthis, SE NW SE Section 34, and have started their No. 3 Cantrell, NE SE SE Section 34, which was drilling below 300 ft. Beal & LeVieux, of Okemah, have the drilling contract. Location of 2 wells completed by Foundation Oil Co. and locations for 2 additional tests are shown on the map. Associated with W. M. Dunn in this activity are Clyde S. Miller and M. A. Breckenridge, all of Tulsa. H. F. Worley, J. H. Kramer and associates, also of Tulsa, operating as the Foundation Oil Co., are interested in the other tests.

The Dunn pool, although a new producing area, is located in the heart of one of the older oil sectors of Oklahoma. It is in the extreme southeastern corner of Creek County, immediately north of the Okfuskee County line and about 1¼ miles west of the Okmulgee County line. It is south of the old Tuskegee area of Creek County, north of the Okfuskee pool in the county of that name and west of the Nuyaka pool in Okmulgee County.

In the heart of the St. Louis district of Pottawatomie County, Tilico Oil Co. deepened their No. 2 Brister, NW NW NE Section 28-7-4, to find rich production in Wilcox sand. Originally bottomed at 4,164 ft., it was deepened to Wilcox sand at 4,292-4,302 ft., total depth, swabbed 855 bbl. of oil in 20 hours and was rated good for 870 bbl. of oil daily.

As a result of this strike, 7 other operations were started in the immediate area. They are: Tilico Oil Co.'s No. 3 Brister, SW NW NE Section 28-7-4, an old well, rigging up standard tools to deepen from 4,135 ft.; Magnolia Petroleum Co.'s No. 3 Brister, NW SW NE Section 28-7-4, twin well, rigging up rotary; Sinclair Prairie Oil Co.'s No. 2 Deatheridge, NE NW NW Section 28, an old well deepening from 4,137 ft., drilling below 4,149 ft.; same company's No. 3 Deatheridge, SE NE NW Section 28, an old well deepening from 4,152 ft., drilling below 4,236 ft.; same company's No. 5 Deatheridge, NW NE NW Section 28, an old well bottomed at 4,146 ft., rigging up standard tools to deepen; same company's No. 7 Deatheridge, SE NW NW Section 28, drilling below 520 ft.; Phillaine Oil Co.'s No. 4 Garrett, NE SW NW Section 28-7-4, drilling below 600 ft.

The largest producer yet drilled on Cement townsite in the Caddo County field of that name was near completion at Johnson & Rollins' No. 1 test, block 28 of the townsite. It found lower Rowe sand at 3,420-51 ft., total depth, and made potential of 5,472 bbl. of oil. Upper Rowe sand at 3,322-53 ft. was to be tested through perforations later. Elsewhere in the field a 3,362 bbl. well was completed.

The third producer in the Hobart field, Kiowa County, was completed at Shell Oil Co.'s No. 1 Kelsay, NW NW SW Section 20-7-17w, south offset to the discovery well. It flowed 140 bbl. of oil in 4 hours from best oil pays at 1,131-41 ft. and 1,150-59 ft., total depth. A west offset to the new producer was being started at Phillips Petroleum Co.'s No. 1 Warren, NE NE SE Section 19-7-17w. The pool was opened last May.

## Among the Wildcats

An Oklahoma County pool opener was completed at Hall-Briscoe, Inc.'s No. 1 Thompson, SW SW NE Section 28-13-1e, east of the town of Jones. It topped second Wilcox sand at 5,998 ft., was bottomed at 6,058 ft., plugged back to 5,158 ft. and set 7-in. pipe at 5,133 ft. Casing was perforated and it was shot in Cleveland-sand zone at 4,796-4,808 ft. and pumped 100 bbl. of oil and 10 bbl. water daily. Gravity of the oil was 35°.

R. L. Kemp's No. 1-A Burke, NE SW NE Section 20-17-6, wildcat in northeastern Lincoln County, was shot at 2,865-2,900 ft. in Prue sand and completed for 25 bbl. of oil and 2,960,000 cu. ft. of gas daily. Total depth was 2,908 ft.

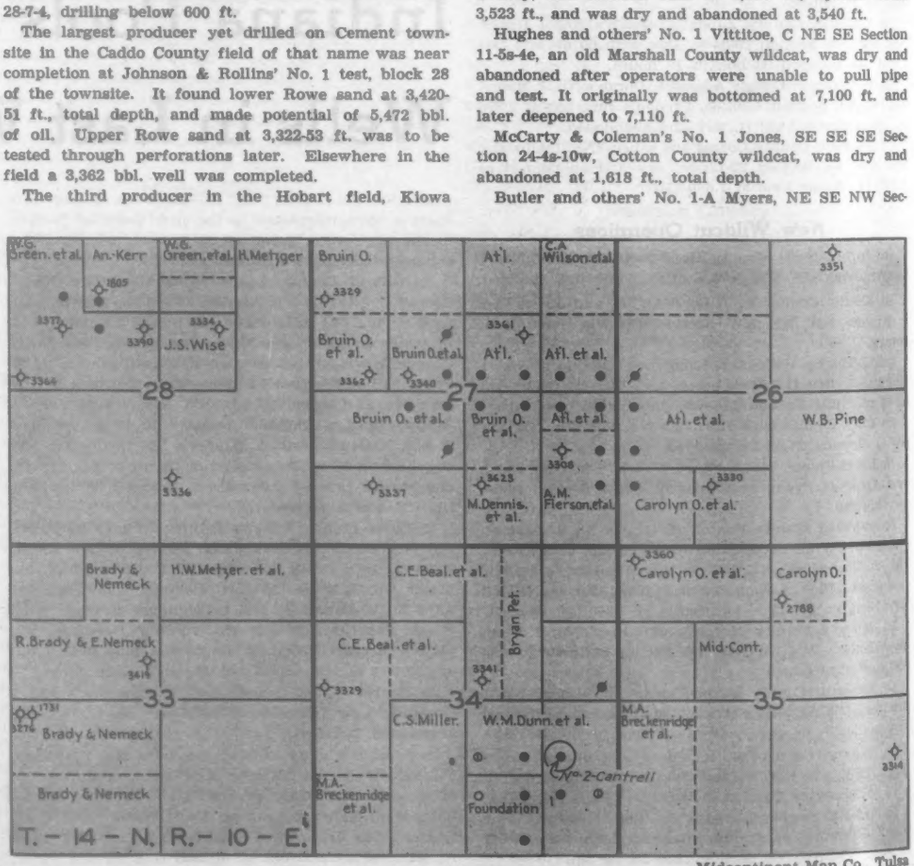
Vierson's No. 1 Judeman, SW SE NW Section 24-14-10, outpost in southeastern Creek County, found Wilcox sand at 3,170 ft., total depth 3,184 ft., with a showing of oil. Casing collapsed, hole was lost and it was abandoned.

Scruggs and others' No. 1 Lanning, SE SW SW Section 19-12-15, wildcat in the Hitchita area, McIntosh County, had Hunton lime at 3,512 ft., Sylvan shale 3,523 ft., and was dry and abandoned at 3,540 ft.

Hughes and others' No. 1 Vittitoe, C NE SE Section 11-5s-4e, an old Marshall County wildcat, was dry and abandoned after operators were unable to pull pipe and test. It originally was bottomed at 7,100 ft. and later deepened to 7,110 ft.

McCarty & Coleman's No. 1 Jones, SE SE SE Section 24-4s-10w, Cotton County wildcat, was dry and abandoned at 1,618 ft., total depth.

Butler and others' No. 1-A Myers, NE SE NW Sec-




Midcontinent Map Co., Tulsa

*W. M. Dunn and others' No. 2 Cantrell, Section 34-14-10, fifth producer in the Dunn pool, Creek County, flowed 2,350 bbl. of high gravity oil in 38 hours from Misener sand*

tion 25-7-21w, Greer County wildcat, was dry and abandoned at total depth of 1,228 ft.

New wildcat operations included: Patsy Oil Co.'s No. 1 Garrett, NW NE NE Section 15-5-3e, southeastern McClain County, location; J. F. Smith and others' No. 1 Corbett (Higbee), C SW NE Section 20-6-1e, near Lexington, Cleveland County, an old well bottomed at 6,760 ft., was cleaning out at 560 ft.; Phillips Petroleum Co.'s No. 1 Blankenship, C SW NW Section 33-10-13, western McIntosh County, cellar and pits; Kaplan's No. 1 Mills, NW NW SE Section 12-15-9, Creek County, cellar and pits; Foundation Oil Co.'s No. 1 Osage, NW NW SE Section 3-25-3e, western Osage County, drilling below 950 ft.

### Pottawatomie County

Kerlyn Oil Co.'s No. 1 Ogee, NE NW NE Section 17-7-5, outpost on the east side of the St. Louis district, Pottawatomie County, found Calvin sand at 2,830-51 ft., total depth 2,864 ft., and set 8-in. casing at 2,840 ft., with 2½-in. tubing at 2,858 ft. It flowed 577 bbl. of 42-gravity oil through ¾-in. choke in 24 hours, with bottom-hole pressure of 1,195 lb.

Skelly Oil Co.'s No. 3 Decker, SE SW SW Section 16-7-4, an old well, was plugged back from 4,148 ft. to 3,530 ft., casing was ripped and it was shot at 3,490-3,508 ft., flowing 70 bbl. of oil in 24 hours.

Magnolia Petroleum Co.'s No. 4 Fyke C, NE SE SE Section 20-7-5, found sand at 2,820-31 ft., total depth, set 7-in. pipe at 2,820 ft. and flowed 110 bbl. of oil in 24 hours.

Watchorn Oil & Gas Co.'s No. 2 Coleman, NW NE NW Section 33-7-5, topped dolomite at 4,187 ft., total depth 4,220 ft., and plugged back to 3,170 ft. After perforating casing at 2,985-3,160 ft., it pumped 20 bbl. of oil and 25 bbl. of water in 24 hours.

New operations in Pottawatomie County included: J. F. Smith's No. 2 Latimer, SW NW NW Section 21-7-4, rig; Neville's No. 1 Cowan, SE SE NE Section 35-10-4, set 12-in. pipe at 53 ft., building rig.

T. C. Iglehart's No. 1 Campbell, SW NE SW Section 4-6-5, southeast of the St. Louis district, found dolomite at 4,070-97 ft., total depth, was acidized and swabbed 665 bbl. of oil in 24 hours, plus 15 per cent water. It later pumped 250 bbl. of oil and an equal amount of water in 24 hours, but was not a completion.

### Seminole County

Wood Oil Co.'s No. 1 Ashby, SW NE NW Section 22-7-5, an old well in Seminole County, was plugged back from 4,250 ft. to 2,877 ft., ripped casing and was shot at 2,785-93 ft., and pumped 2 bbl. of oil daily.

First reports of new work in Seminole County: Harry Culver and others' No. 1 Swan D, NE SE SW Section 3-5-5, cellar and pits; Simpson-Roodhouse Drilling Co.'s No. 2 Stewart, NW SW SW Section 14-6-6, rig; Baker's No. 2 Newell, SW NW NE Section 3-10-5, cellar and pits.

Culver & Shepherd and others' No. 1 Swan C, NW SW SE Section 3-5-5, Burton pool, topped Hunton lime at 2,527 ft., set 8-in. casing at 2,517 ft. and was bottomed at 2,700 ft. It was acidized and swabbed 84 bbl. of oil in 24 hours and was being put on pump.

In the Konawa district, Summers' No. 1 Caesar, SW SW SW Section 21-6-6, swabbed 350 bbl. of oil in 24 hours after acidizing dolomite topped at 3,549 ft., total depth 3,594 ft. It was not a completion.

Baker's No. 1 Newell, SE NE NW Section 3-10-5, North Earlsboro area, topped Wilcox sand at 4,623 ft., total depth 4,629 ft., swabbed 199 bbl. of oil in 12 hours and pumped 100 bbl. in 16 hours, but was not completed.

### Pontotoc County

E. H. Moore, Inc.'s No. 6 Brown, SE NE SW Section 34-2n-7, Fitts district, Pontotoc County, was an abandoned location.

R. H. Pierce's No. 2 Pettyjohn, SW SE SW Section 1-1n-7, was a location. H. & M. Drilling Co.'s No. 6 Harrell, CWL NE SE Section 29-5-8, was a machine.

### Lincoln County

Yorkan Production Co.'s No. 1 Tipken, C NW SW Section 15-13-6, Laffoon area, Lincoln County, topped Viola lime at 4,208 ft., dolomite 4,255 ft., Wilcox sand 4,279 ft. and was bottomed at 4,288 ft. It was plugged back, perforated between 4,080-4,120 ft., and acidized, producing 11,250,000 cu. ft. of gas daily, with 1,220 lb. rock pressure.

Conley's No. 1 Selby, NE NE NE Section 8-15-6, Skellyville pool, was acidized and pumped 32 bbl. of 44.2-gravity oil the first 24 hours and 10 bbl. of oil and 5 bbl. of water the next 24 hours. It found Hunton lime at 3,895 ft., Sylvan shale 3,917 ft. and was bottomed at 3,938 ft.

Wilcox Oil & Gas Co.'s No. 1 School Land, NE SE SW Section 16-14-6, Sac and Fox pool, was digging cellar and pits.

In Latimer County, Limestone Oil Co.'s No. 2 Kilpatrick, C SW NW Section 16-5-18, was drilling below 790 ft.

### Pawnee County

Magnolia Petroleum Co.'s No. 11 Miller, C W½ NW Section 4-22-3e, Watchorn pool, Pawnee County, found sand at 2,242-46 ft., total depth, and was completed for 250,000 cu. ft. of gas daily.

Jackson's No. 1-A Besser, SE SW SE Section 24-20-9, was drilling below 85 ft.

### Payne County

Mid-Continent Petroleum Corp. and others' No. 7 Brandon, SW SE NE Section 13-18-1e, Ramsey pool, Payne County, drilled Wilcox sand at 4,777-4,800 ft., total depth, and was completed for daily potential of 5,610 bbl. of oil. It flowed 239 bbl. of oil and 3,375,000 cu. ft. of gas the first hour and 228 bbl. of oil and 3,340,000 cu. ft. of gas the second hour and then was shut in. It is in the west line of producers on the community block.

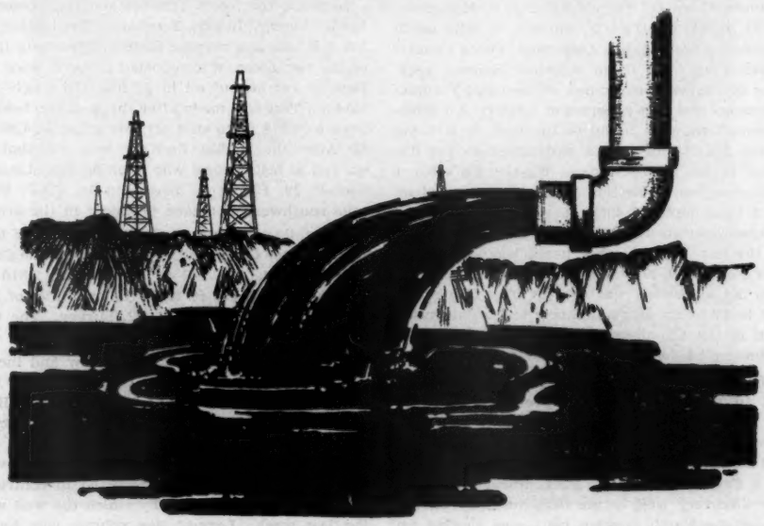
A new Payne County operation was reported at Mulberry Oil Co.'s No. 9 Booyles, NW NE NW Section 26-18-4, drilling below 200 ft.

### Hughes County

Canavan's No. 1 Burke, C NW NE Section 8-8-10, an old well in Hughes County, being deepened from 3,200 ft., was drilling below 3,525 ft.

Davon Oil Co.'s No. 1 White, C N½ NW SE Section 5-8-10, North Yeager area, was reported to have flowed 768 bbl. of oil and 250 bbl. of water in 24 hours, pinched, with gas measuring 15,000,000 cu. ft. Gravity of the oil was reported to be 43°. Total depth was 3,875 ft., but operators withheld information.

*(Continued on Page 244)*

# Starting the Flow

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# West, Central and Panhandle Texas

By
D. H. STORMONT

# Increased Work in Central Area; 2 Apco Outposts Dry

MIDLAND, Tex., Nov. 13.—Cutting off production on two sides of Pecos County's recently discovered Apco (Ellenburger of Lower Ordovician) pool and the testing of a possible producer in the pool proper, together with the testing of an offset to Ector County's North Cowden pool deep pay, featured activity in the West Texas district.

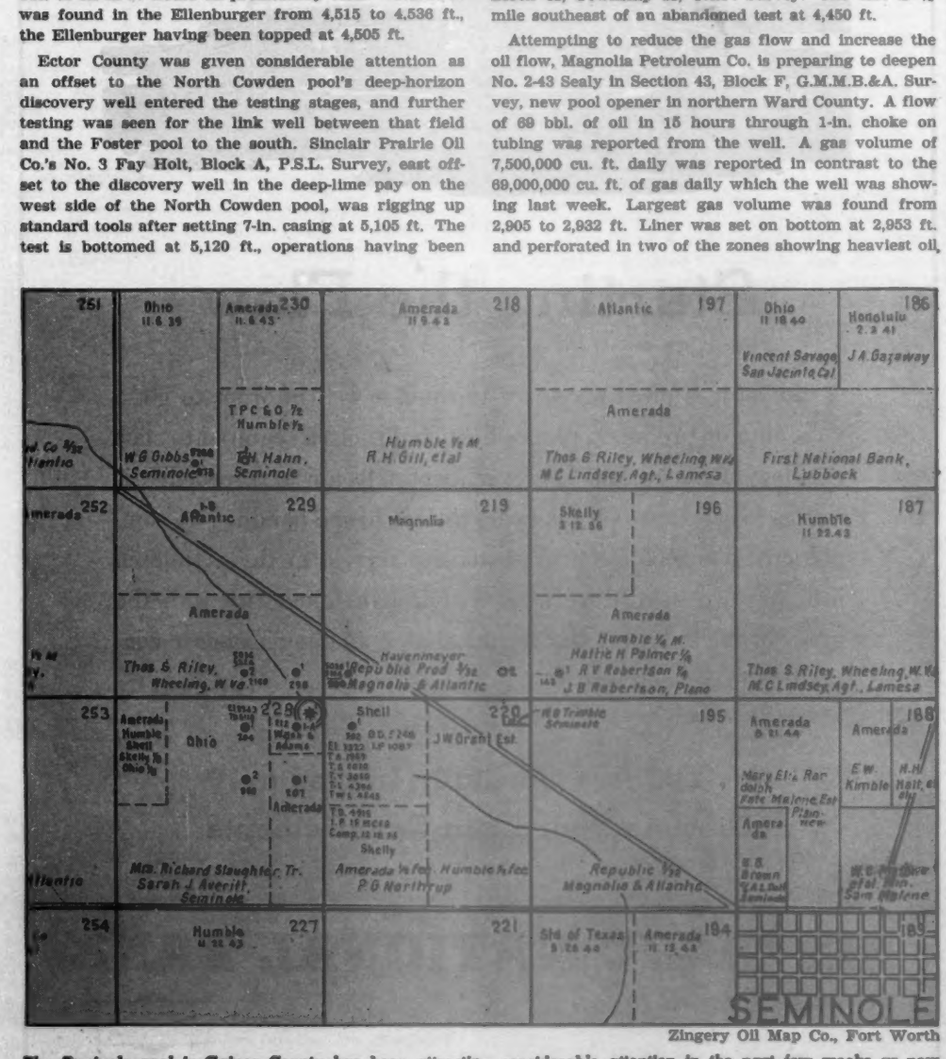
Anderson-Prichard Oil Corp.'s No. 2 J. S. Masterson, Section 104, Block 10, H.&G.N. Survey, ½ mile north of the discovery well in the Apco pool, Pecos County, was bottomed at 4,740 ft. in schistose igneous rock. Top of the detrital zone at contact of the basal Permian and the igneous rock was reported at 4,515 ft. No Ellenburger formations were found in the test. It is being plugged for abandonment. An east offset to the discovery well in the field, Childress Royalty Co.'s No. 1 J. S. Masterson, also in Section 104, was dry and abandoned at a total depth of 4,605 ft. with the top of the detrital zone reported at 4,495 ft. No Ellenburger was found in the test. On the other hand, Magnolia Petroleum Co.'s No. 1 J. S. Masterson, extending production ¼ mile to the southwest, was shut in after flowing 53 bbl. of oil in 17 hours on preliminary tests. Saturation was found in the Ellenburger from 4,515 to 4,536 ft., the Ellenburger having been topped at 4,505 ft.

Ector County was given considerable attention as an offset to the North Cowden pool's deep-horizon discovery well entered the testing stages, and further testing was seen for the link well between that field and the Foster pool to the south. Sinclair Prairie Oil Co.'s No. 3 Fay Holt, Block A, P.S.L. Survey, east offset to the discovery well in the deep-lime pay on the west side of the North Cowden pool, was rigging up standard tools after setting 7-in. casing at 5,105 ft. The test is bottomed at 5,120 ft., operations having been halted at that depth after a core from 5,105 to 5,117 ft. returned 10 ft. of oil-stained and slightly porous lime. This well, if successful, will be the third in the new deep pay, the Stanolind Oil & Gas Co.'s No. 1-A Blakeney, 3½ miles south of the discovery, having been officially gaged the past week at 43 bbl. daily from the lime from 5,120 to 5,160 ft.

Between the North Cowden and the Foster pools in Ector County, Indian Territory Illuminating Oil Co.'s No. 1-B Johnson, serving further to indicate the linking of the two areas, was reported to have made a natural flow of 142 bbl. of oil in 24 hours through open 2-in. tubing. Test was made after the well had been plugged back to 4,178 ft. to shut off salt water at 4,182 to 4,185 ft. After the 142-bbl. flow the well was shot with 330 qt. and at last reports was cleaning out. Location is in Section 39, Block 43, Township 1s, T.&P. Survey, ½ mile southwest of a lone producer in the area.

A ½-mile-north outpost to the east side of the Foster pool in Ector County has been staked by the Continental Oil Co. as its No. 1-B J. L. Johnson, 2,310 ft. from the north and 1,650 ft. from the east lines of Section 5, Block 42, Township 2s, T.&P. Survey. The test is ¾ mile southeast of an abandoned test at 4,450 ft.

Attempting to reduce the gas flow and increase the oil flow, Magnolia Petroleum Co. is preparing to deepen No. 2-43 Sealy in Section 43, Block F, G.M.M.B.&A. Survey, new pool opener in northern Ward County. A flow of 69 bbl. of oil in 15 hours through 1-in. choke on tubing was reported from the well. A gas volume of 7,500,000 cu. ft. daily was reported in contrast to the 69,000,000 cu. ft. of gas daily which the well was showing last week. Largest gas volume was found from 2,905 to 2,932 ft. Liner was set on bottom at 2,953 ft. and perforated in two of the zones showing heaviest oil saturation. Test has been acidized with 2,000 gal. According to last reports the perforations had been cemented off and the operator was preparing to deepen several more feet into the pay section.




Zingery Oil Map Co., Fort Worth

*The Seminole pool in Gaines County has been attracting considerable attention in the past few weeks as new producers continue to expand its yet undefined limits*

## North Basin Area

Gaines County led development in the North Basin area with activity being reported from the Seminole pool and the recently opened Cedar Lake field. Atlantic Refining Co.'s No. 1-B Riley, Section 229, Block G, W. T. Survey, north of the Seminole pool proper, was fishing for drill collar after encountering gas from 3,200 to 3,215 ft. which caused a blowout. It is a south offset to the Ohio Oil Co.'s No. 1 Gibbs, mile north extension. Amerada Petroleum Corp.'s No. 1 Averitt, Section 228, producer on the south edge of the field which is being drilled deeper, was below 5,157 ft.

n the Cedar Lake field in the northeastern part of Gaines County, Stanolind Oil & Gas Co.'s No. 1 American Warehouse Co., west offset to the company's discovery well, was bottomed at 2,669 ft. and running casing. The same company's No. 1 A. L. Green, Section 5, Block 30-C, P.S.L. Survey, south offset to the discovery, was drilling below 2,090 ft. The company's No. 1 T. S. Riley, wildcat test 3½ miles northwest of the discovery, has been spudded to 250 ft. where the crew was reaming pipe. It is located in Section 11, Block 8, D.&W. Survey.

In the extreme northern part of the Permian basin and almost in the southern Panhandle area, Motley County, will be given a deep wildcat test. Location was staked by Humble Oil & Refining Co. in the southwestern part of the county. It is the second deep test by the firm on the Matador Land & Cattle Co. ranch which consists of 466,525.98 acres and is under lease to the Humble. The first effort, No. 1 Matador, in northern Dickens County, failed to encounter any pay in drilling to a total depth of 7,074 ft. and was abandoned. The No. 2 Matador will be drilled 330 ft. from the east and 6,500 ft. from the north lines of the Blanco County School Lands' No. 1, with location falling approximately 16 miles northwest of the Dickens County failure. Tools are being moved in for immediate activity at the location.

## WEST CENTRAL TEXAS

Fort Worth, Tex., Nov. 13.—New and increased activity for four fields in the West Central Texas district marked a busy week in the area. A new development campaign for the Ivy pool in Shackelford County, extensions and new locations for the Bowles pool in Taylor and Callahan counties, activity in Stephens County, and completion of a new producer in the recently opened Shanafelt pool of Jack and Young counties, headed the week's development.

With activity lagging during the past few weeks in the Ivy pool of northwestern Shackelford County, a 26-well drilling campaign in the northwest part of the pool was seen during the week. Clyde O. Eastus purchased a 137-acre tract in the western part of the De-Etta Martin 275-acre farm in Section 16, Block 3, H.&T.C. Survey and plans to drill wells to both the 1,920 ft. King sand and the 3,200-ft. Palo Pinto-lime horizon, both being productive in the pool proper. Deep lime wells will first be drilled with the twin wells being drilled when commercial production is indicated in the deep holes.

The Bowles pool on the Taylor and Callahan County line was set for two new completions on two sides of a recently completed north outpost. Offsetting Bradford & Robertson's No. 1 Reeves, SE cor. NW¼ Section 28, B.A.L. Survey, the same operators were testing after reporting a preliminary gage of 864 bbl. daily at their No. 2 Reeves. Offsetting No. 1 Reeves to the east, S. B. Roberts was cementing pipe at No. 1 Mitchell. A half

mile north of the field, Joe Evans' No. 1 Gist, approximately the center of Section 18, was nearing the critical point in drilling below 1,580 ft. Several new operations have been staked in the south and southeastern part of the field to bring the total number of active tests in the field to eight.

Potential gage has been reported for the T. G. Shaw, trustee's No. 1 Stroud, opening a new pool in the extreme northeastern part of Stephens County. The well, in the northwest quarter of the G. Newton Survey, topped pay in the Kisinger sand at 2,598 ft. and penetrated it only 4 ft. where drilling was halted for completion. Railroad Commission gage of 165 bbl. of oil in 24 hours, flowing through 2-in. tubing, was reported. The operator plans a development campaign for the lease which will commence at once.

Also in Stephens County and creating considerable excitement during the week was Pitzer & West's No. 2-B J. S. Pierce, in Block 74, in the townsite of Breckenridge. Gas sand from 2,970 to 3,976 ft. was found early in the week and operators bottomed the well in an attempt to kill the flow. This is the first deep test to be drilled in the townsite and possibilities are seen for a deep pool under the old Breckenridge townsite pool.

On the Young and Jack County line and near the new pool opener of last summer by Nelson Oil Syndicate on the Birdwell lands, Danciger Oil & Refineries, Inc., has reported a flow of 160 bbl. in 4 hours for No. 2-A Bailey, third producer in the new field. Pay was found in the Marble Falls lime from 4,345 to 4,358 ft., total depth 4,430 ft. Taubert & McKee completed No. 1 Shanafelt several weeks ago to provide the second producer in the field. Several deep tests in the area are either drilling or waiting on completion gages. The new well is located in the A. Bailey Survey, Abstract 1597, southwest of Bryson and near the Jack County line.

## WEST TEXAS FIELD COMPLETIONS

(24-hour gages)

### Andrews County

In the Means pool Humble Oil & Refining Co.'s No. 60 J. S. Means, 4,316-4,537 ft., 184 bbl. Humble's No. 69 Means, 4,261-4,534 ft., 655 bbl.

### Cochran County

A wildcat test, Humble Oil & Refining Co.'s No. 1 Westheimer, dry and abandoned at a total depth of 7,414 ft.

### Crane County

In the Sand Hills pool Gulf Oil Corp.'s No. 19 Henderson, 3,495-3,582 ft., 456 bbl. In the McElroy pool Gulf Oil Corp.'s No. 203 McElroy, 2,668-2,885 ft., 202 bbl. In the McCamey pool Superior Oil Co.'s No. 2 Hughes, 2,245-2,422 ft., 109 bbl. (old well drilled deeper).

### Crockett County

Clark & Cooper's No. 2 Shannon, dry and abandoned at total depth of 2,610 ft.

### Ector County

In the Foster pool Atlantic Refining Co.'s No. 7 Henderson, 4,000-4,200 ft., 738 bbl. Broderick & Calvert's No. 14 Witcher, 3,975-4,171 ft., 2,027 bbl. Broderick & Calvert's No. 15 Witcher, 4,105-4,225 ft., 863 bbl. Continental Oil Co.'s No. 7 Johnson, 4,140-4,260 ft., 386 bbl. Sinclair Prairie Oil Co.'s No. 8 Corrigan, 4,345-4,404 ft., 902 bbl. Stanolind Oil & Gas Co.'s No. 29-B E. F. Cowden, 4,020-4,165 ft., 1,212 bbl. Stanolind Oil & Gas Co.'s No. 28-A E. F. Cowden, 4,045-4,175 ft., 647 bbl. In the North Cowden field Stanolind Oil & Gas Co.'s No. 1-A Blakeney, 5,120-60 ft., 43 bbl. Stanolind Oil & Gas Co.'s No. 20 Roberts, 4,245-4,500 ft., 284 bbl.

### Gaines County

In the Wasson area Amon G. Carter's No. 2-A Moore, 4,890-5,022 ft., 333 bbl. Amon G. Carter's No. 3-E Wasson, 4,915-5,012 ft., 331 bbl.

### Hockley County

E. T. Marion's No. 1 P. F. Lawless, 4,882-4,980 ft., 621 bbl.

### Loving County

In the Mason pool Michigan Oil & Gas Co.'s No. 10 Kyle, 3,886-3,922 ft., 426 bbl.

### Pecos County

In the Apco pool Anderson-Prichard Oil Corp.'s No. 2 Masterson, dry and abandoned at total depth of 4,740 ft. in igneous rock. Childress Royalty Co.'s No. 1 J. S. Masterson, dry and abandoned at total depth of 4,605 ft. in igneous rock. In the Taylor-Link pool Landreth Production Co.'s No. 4-E University, 1,625-45 ft., 198 bbl.

### Upton County

In the McCamey pool, Lee's No. 1 Burleson-Shell, 2,205-87 ft., 20 bbl. (old well drilled deeper). Shell Oil Co., Inc.'s No. 13 Baker, dry and abandoned at total depth of 245 ft. Texas Pacific Coal & Oil Co.'s No. 40-A Lane, 2,005-51 ft., 365 bbl.

### Ward County

In the Hutchins pool Gulf Oil Corp.'s No. 7 Hutchins, 2,490-3,082 ft., 294 bbl. (old well drilled deeper). In the Estes pool Gulf Oil Corp.'s No. 118 O'Brien, 2,735-2,852 ft., 105 bbl.

### Winkler County

In the Keystone pool Standard Oil Co. of Texas' No. 21-19 Baird, 3,240-3,462 ft., 192 bbl. Adams, Hitchock & Bradley's No. 1-B Lech, 3,056-3,134 ft., 80 bbl. Gulf Oil Corp.'s No. 73 Daugherty, 2,928-3,037 ft., 353 bbl.

### Howard County

Sinclair Prairie Oil Co.'s No. 63 Dodge, 2,660-2,795 ft., 234 bbl.

### Yoakum County

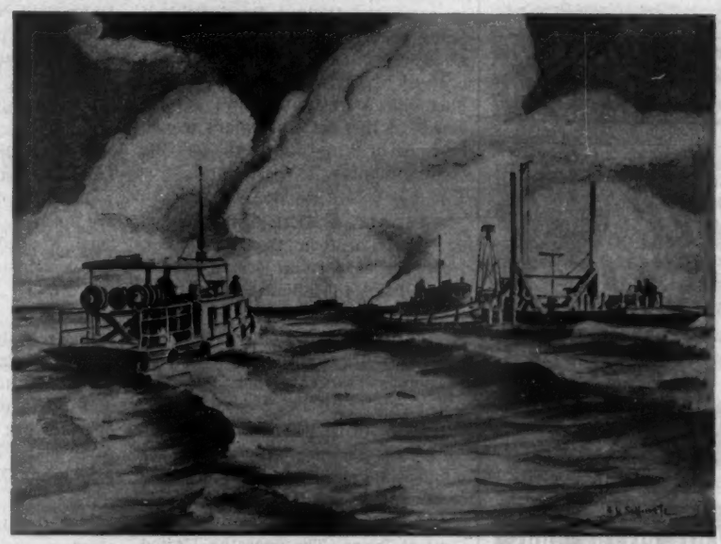
In the Wasson-Bennett field Gulf Oil Corp.'s No. 2 Futch, 5,020-5,215 ft., 382 bbl. Magnolia Petroleum Co.'s No. 8 Kendrick, 4,915-5,150 ft., 1,128 bbl. Magnolia Petroleum Co.'s No. 2 Mahoney, 5,030-5,330 ft., 1,028 bbl. Oil Development Co.'s No. 2-801 fee, 3,834-5,220 ft., 510 bbl. Skelly Oil Co.'s No. 1 W. W. Hancock, 5,090-5,234 ft., 1,080 bbl. Texas Pacific Coal & Oil Co.'s No. 2 Brownfield, 5,003-5,175 ft., 1,033 bbl.

## WEST CENTRAL TEXAS COMPLETIONS

### Brown County

Ed Selvidge's No. 9-A fee, dry and abandoned at total depth of 1,212 ft.

*(Continued on Page 239)*

Geophysical Exploration, Gulf Coastal Waters. From a lithograph by E. M. Schiwetz

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# Among the Drilling

MANAHAN DRILLING CO., North Texas contracting firm, is moving in and rigging up at Magnolia Petroleum's No. 1 Ramsey, outpost east of production in the Walnut Bend pool of Cooke County, North Texas. Magnolia Petroleum Co. is the third firm to enter the Walnut Bend field, it being opened by Sinclair Prairie Oil Co. early in 1938 and last summer entered by Cox & Hamon of Dallas. Magnolia recently acquired several leases in the field and plans a continuous drilling campaign for the coming months.

RANDALL & KEIL have spudded a new wildcat in Denton County, North Texas, for the Kerlyn Oil Co. on the Ida Mae Hallmark farm. Location is in the D. C. Cody Survey, southwest of Pilot Point. Contract depth is the Ellenburger formation expected at around 3,500 ft.

RHODES DRILLING CO., of Stamford, Tex., has received contracts for a four-well drilling program for Clyde O. Eastus in the Ivy pool of northwestern Shackelford County, West Central Texas. The operator, United States district attorney for the northern district of Texas, recently acquired 137½ acres northwest of the pool proper and in the western part of the 275-acre DeEtta Martin farm in Section 16, Block 3, H.&T.C. Survey. The operator plans to test both the King sand and the Palo Pinto lime, both levels being productive in the pool. Twin wells will be drilled on each location. The King sand is expected at about 1,920 ft. and the deeper Palo Pinto lime at about 3,200 ft. A total of 26 wells is planned for the tract should the entire acreage yield production.

A. C. WALKER, drilling contractor of Grand Falls, Tex., has been awarded the contract for a three-well development program on shallow acreage in the northern part of Pecos County, West Texas. McGinley & Davis, Fort Worth, have 640 acres leased in Section 22, Block 10, H.&G.N. Survey, and the first test is planned 2,310 ft. from the northwest and 330 ft. from the south lines of the section. The lease is 3½ miles west of the deep Ellenburger projected wildcat of Humble Oil & Refining Co. on the Young tract in Section 33. The operators plan an Ordovician test should production be found in the Humble wildcat.

ALLEN & MORRIS opened a new sand in the North Luby field, Nueces County, Southwest Texas, as 5½-in. casing was cemented on bottom in Seaboard Oil Co.'s No. 4-A LaPrelle after the well flowed pipe-line oil on a drill-stem test at 5,073-85 ft. Another operation was started in the La Rosa field, Refugio County, for Coronado Corp., while in the Agua Dulce field, Nueces County, two operations are reported for Process Oil Co. and Agua Dulce Oil Co.

FALCON-SEABOARD Drilling Co. is moving two rotaries to the Napoleonville salt dome, Assumption Parish, coastal Louisiana. The two wells to be drilled for the company are located in an area which has been worked extensively with geophysical instruments.

GEORGE ECHOLS is moving a rotary to Galveston Island, Galveston County, Texas, for Hebert & Smith's No. 1 J. A. Harris in the Edward Hall and Levi Jones Survey. The same operator has another operation at the Allen dome, Brazoria County, Texas, for Titanic Oil Co.

T. A. CARLTON spudded No. 1 Abe Gordon, a wildcat, north of the town of Satsuma in Harris County, Texas. The well is being drilled jointly with Dick Schwab and will be drilled to a total depth of 6,500 ft.

JOHN BLAFFER spudded his No. 1 Williams, a south outpost test in the Lovells Lake field, Jefferson County, Texas, and another operation was started for himself in the Thompson field, Fort Bend County.

ROWAN & HOPE are starting a wildcat east of the Benavides field, Duval County, Southwest Texas. The well is located on the Lopez lease in Survey 544.

PITZER & WEST, Breckenridge, Tex., together with the Brazos Young Oil Corp., have staked an outpost to the new Loving pool in Stephens County, Texas, opened last summer by Wittmer Oil & Gas and Ewing & Knight 3 miles southeast of the old deep Ibex pool. The outpost will be operators' No. 1 N. Price, 660 ft. from the south and east lines of E½ SW Section 67, B.A.L. Survey, 14 miles southwest of Breckenridge. Scheduled to be drilled with cable tools, the project will test to 5,000 ft. or Ellenburger lime if the Caddo lime is not found productive at around 3,500 ft.

JAMES H. GREEN, contractor of Brownwood, Tex., has received contract from A. W. Tanner for his No. 1


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M. J. Ivy, new wildcat in Mills County, Central Texas. Location is 2 miles southwest of Ebony and 3 miles east of the Brown County line and in the M. Rhyne Survey. It will test the lower Strawn and possibly the Ellenburger in drilling to a contracted depth of 1,450 ft.

ZEB DRILLING CO. completed a fishing job and was drilling below 6,355 ft. at No. Highland in NE NW SW SE Section 26-12-3w in the Oklahoma City field, Oklahoma.

H. M. S. DRILLING CO. and W. N. Dannenburg announce the location for a 2,500-ft. test in NE cor. NW¼ of Section 36-17-10e, at the southeast edge of the Kellyville district, Oklahoma, and in an area in the limelight lately. O. B. Hausam, of the H. M. S. Drilling Co., says the test is on a well-defined structure.

BIG CHIEF DRILLING CO. at No. 2 Youts, SE NW SW Section 28-7-5, Pottawatomie County, Oklahoma, was swabbing 20 bbl. of oil an hour from the dolomite at 4,085 ft.

PARKER DRILLING CO. of Texas has the contract for a wildcat to be drilled for Barnsdall Oil Co. on the Three Creeks block, Union County, Arkansas. The test, No. 1 Cameron, is located near Junction City.

HELMERICH & PAYNE, INC.'S No. 1 LaGrange, NW NW NW Section 8-23-3w, Garfield County, Oklahoma, had top of the Fourmile at 1,920 ft., top of the Pawhuska at 2,310 ft. Operators are drilling below 4,155 ft.

STAUFFER PETROLEUM CO., of Oklahoma City, has awarded contract to Hugh Pierce for drilling No. 1 Smith, Section 28-7-8w, wildcat on a 6,000-acre block near Verden in Grady County, Oklahoma. Objective is Wilcox sand expected around 6,500 ft.

CLAUDE DRILLING CO. and others of Tulsa drilled No. 1 Petz, a semiwildcat in the NW SW Section 14-19-11w, between production in the Eberhardt and Lanterman pools of Barton County, Kansas, on a farmout from Shell Oil Co., Inc. The well was dry and abandoned at a total depth of 3,481 ft.

ROWAN & HOPE, INC.'S No. 1 Dallas Joint Stock Land Bank, a semiwildcat in the Rincon area, Starr County, Texas, was abandoned as a failure at a total depth of 4,506 ft. Slight showings of gas and distillate were logged at 3,939-47 ft., but drill-stem testing proved unsuccessful.

ALLEN & MORRIS are starting a new operation in the Agua Dulce field, Nueces County, Texas, for Process Oil Co. In the East White Point field, the contractors are drilling below 3,300 ft. on their No. 3 Baldwin, while in Refugio County, two rotaries are running for the Coronado Corp. and Agua Dulce Oil Co.

*A Trinity Drilling Co., Dallas, Tex., crew takes time out to be snapped while repairing a mud pump on a rig drilling in the Cooper-sand field of Lea County, New Mexico*


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# California Field Report

By
L. P. STOCKMAN

# Atkinson Bill's Defeat Will Not Cause Undue Drilling

LOS ANGELES, Calif., Nov. 13.—After a hotly contested campaign at the completion of which the Atkinson oil-control bill was defeated producers, marketers, and refiners are back to normalcy. The concern of these branches of the oil industry was because the Atkinson control measure gave the director of natural resources jurisdiction over all operations from production to sale, but the result indicated that they need have had no anxiety. There will be no general unrestricted exploitation program started nor will there be any disruption in marketing practices. A normal increase in drilling may be anticipated inasmuch as the uncertainty existing just prior to the vote on the bill had a tendency to retard work pending clarification of the issues involved.

The development program involving exploitation of La Merced zone in the west end of the Montebello field is nearing completion although no immediate decline in production can be expected as the court's temporary injunction is still in effect and thus operators will be forced to comply with its provisions regarding elimination of gas waste. This temporary injunction was issued under provisions of the California Gas Conservation Act, which prohibits gas waste, and it did not require an oil-control bill to accomplish the desired result. No move has been made to proceed with deeper drilling in the Montebello extension and the next move will be to attempt to have the temporary injunction made permanent in order to govern future production of both La Merced zone and any additional ones that might underlie this horizon. There is no reason why one or more productive measures should not be found under La Merced zone and thus every precaution will be taken to prevent any blow of gas to the air.

## Montebello Situation

The Montebello field is still the most active district in the state from a drilling standpoint, although the peak of development was passed more than a month ago. Most of the wells now headed down to La Merced zone are around the edge of the field or out on the flanks. Operators have begun to produce the gas zone which is located just above the top of La Merced oil measure, therefore the field is headed downward. For some time operators have been blanking off the high-head gas zone and then perforating after the string of casing had been cemented. Gas production was held back by placing a packer on the tubing. This was done during the course of drilling in order that no time would be lost when it was decided to produce the gas zone, as it required only kicking the packer loose to permit production of the gas with the crude oil. During the past few weeks operators have been producing this gas zone in limited quantities and under restraint, and pressure is slowly being decreased. No regulation is imposed on crude-oil production, the court injunction regulating only gas production and distribution. Operators obviously have been using every legally permissible device to stimulate crude-oil production while at the same time restricting gas production. This is a perfectly legal condition and the most efficient production department secures the largest crude-oil production and minimum production of gas. Valves with and without packers have come into rather general use and are proving of value in operation under the conditions imposed. Voluntary curtailment of crude-oil production and drilling operations have not proved of any great importance in San Joaquin basin fields where most of the acreage in new fields is held in relatively large blocks and operators desire to prolong the period of flush production. This almost universal desire to prolong the period of flush production and extend the productive life of the various fields in the San Joaquin basin is due to the fact that these deep wells are rather costly and must be protected to the maximum extent. When the pumping stage is reached these deep wells will present no simple problem. It is only natural that the investment in deep wells should be protected by curtailing production and extending the flowing life of every well. Because of this, no trouble is encountered in securing adherence to curtailment provisions as set out by the Central Committee of California Oil Producers under the existing voluntary curtailment and proration program. Drilling operations can normally be expected to continue at a low rate in the Wilmington field for several months due principally to exploitation of the tidelands in the Long Beach Harbor section of the Wilmington field and to the drilling of inside locations on leases where offset wells have been completed.

The Rosecrans field is not expected to cause any difficulty from a production standpoint although the productive area south of the Rosecrans field might bear watching during the next few weeks due to the large number of small holdings involved. The importance of the deep zone in the Long Beach field from a production standpoint is still conjectural.

## Los Angeles Basin

Chanslor Canfield Midway Oil Co. recompleted No. 50 Torrance in the Torrance field of Los Angeles County after redrilling and deepening the hole from 4,062 ft. to 5,029 ft. and returned it to production flowing 145 bbl. of clean 27.3-gravity oil per day through an 8/64-in. bean. This well was completed with a solid string of 6⅝-in. casing cemented at 5,029 ft. and then gun-perforated at 4,823-4,992 ft. It is not likely that this well will continue to produce clean oil for any great length of time due to the depleted condition of this deep zone in the general area. The deepening job resulted in increased production and the production of a higher gravity oil which is now within the desirable refining range. In the East Coyote field of Orange County in Los Angeles Basin, Sonwell Oil Co. has completed No. 1 Coyote in Section 13-3-10, pumping 110 bbl. of 22.5-gravity oil cutting 24 per cent daily from 3,384 ft. This well was originally carried down to 3,837 ft. and it is quite possible that the plug put in the bottom of the hole might be defective and thus be responsible for the relatively large cut. The hole was finished with a string of 7-in. cemented at 3,370 ft. and again through perforations at 882 ft. and 3,085 ft. Perforations opposite the productive interval were placed at 3,091-3,370 ft.

## Wilmington

Two new wells and one recompletion were recorded in the Wilmington field of Los Angeles Basin this week but the total new production added only totaled 1,065 bbl. per day. This small aggregate initial daily production is due to the policy of operators of completing new wells at a low rate as the maximum allowable is rather low and no advantage can be gained by permitting a new well to establish a high potential. As a matter of fact operators decided more than a year ago that new wells must make up any overage recorded during potential production tests thus necessitating the suspension of production on any well until the cumulative allowable equaled the total production made on the potential production test. In order to eliminate this shutdown, operators have adopted the practice of completing new wells at a low rate and leaving it to the umpire's office to fix the potential on a computed basis. It is the general expectation that the Ford zone in the Long Beach Harbor section of the Wilmington field will prove highly productive upon exploitation, but Royalty Service again found the zone to be only fair from a production standpoint in the west end or town-lot section of the Wilmington. No. 3 Packard of this company and a former upper-zone well upon being redrilled and deepened

### TANKER SHIPMENTS FROM LOS ANGELES TO DOMESTIC AND FOREIGN PORTS

| | November 5 | | October 28 | | | |
|---|---|---|---|---|---|---|
| | Total this week | Daily average | Total last week | Daily average | This year to date | Same time last year |
| **Intercoastal-domestic—** | | | | | | |
| Crude oil | ..... | ..... | ..... | ..... | 857,366 | 852,826 |
| Fuel oil | ..... | ..... | ..... | ..... | 1,956,841 | ..... |
| Diesel and gas oil | ..... | ..... | ..... | ..... | 163,501 | ..... |
| Gasoline | ..... | ..... | 153,053 | 21,950 | 3,048,371 | 2,631,841 |
| Kerosene | ..... | ..... | 30,347 | 4,335 | 225,197 | 333,626 |
| **Foreign exports—** | | | | | | |
| Crude oil | 425,754 | 60,822 | 182,329 | 26,047 | 12,834,253 | 18,797,054 |
| Fuel oil | 33,580 | 4,797 | 123,797 | 17,685 | 7,478,075 | 7,854,897 |
| Diesel and gas oil | 46,183 | 6,598 | 174,736 | 24,962 | 7,511,535 | 5,118,356 |
| Gasoline | 101,375 | 14,482 | 52,599 | 7,514 | 6,455,385 | 6,954,602 |
| Kerosene | 292,440 | 41,777 | 115,068 | 16,438 | 1,798,580 | 945,523 |
| Lubricants | ..... | ..... | 19,488 | 2,784 | 165,166 | 175,560 |
| **Coastwise-domestic—** | | | | | | |
| Crude oil | 308,418 | 44,060 | 215,380 | 30,769 | 10,687,719 | 10,017,543 |
| Fuel oil | 341,241 | 48,749 | 194,399 | 27,771 | 9,097,740 | 10,365,268 |
| Diesel and gas oil | 35,846 | 5,121 | 35,377 | 5,054 | 1,959,666 | 1,322,288 |
| Gasoline | 362,651 | 51,807 | 303,117 | 43,302 | 14,338,459 | 12,623,781 |
| Kerosene | 13,918 | 1,988 | 30,284 | 4,326 | 489,758 | 210,640 |

### TANKER SHIPMENTS FROM SAN FRANCISCO TO DOMESTIC AND FOREIGN PORTS

| | | | | | | |
|---|---|---|---|---|---|---|
| **Intercoastal-domestic—** | | | | | | |
| Fuel oil | ..... | ..... | ..... | ..... | 124,055 | ..... |
| Diesel and gas oil | ..... | ..... | ..... | ..... | 153,744 | 196,644 |
| Gasoline | ..... | ..... | ..... | ..... | 43,235 | 25,409 |
| Kerosene | ..... | ..... | ..... | ..... | 100,507 | 16,124 |
| Asphalt | ..... | ..... | ..... | ..... | 425,845 | 490,039 |
| Lubricants | ..... | ..... | ..... | ..... | 24,870 | 19,945 |
| **Foreign exports—** | | | | | | |
| Crude oil | 451,782 | 64,540 | 150,926 | 21,561 | 5,007,967 | 4,740,491 |
| Fuel oil | 46,767 | 6,681 | 91,003 | 13,000 | 2,682,062 | 2,288,614 |
| Diesel and gas oil | 30,512 | 4,359 | 137,785 | 19,684 | 2,354,226 | 2,866,135 |
| Gasoline | ..... | ..... | 85,733 | 12,248 | 2,835,325 | 4,788,805 |
| Kerosene | ..... | ..... | ..... | ..... | 554,589 | 696,099 |
| Asphalt | ..... | ..... | ..... | ..... | 14,151 | 56,258 |
| Lubricants | 103,731 | 14,819 | 47,173 | 6,739 | 625,294 | 525,679 |
| Other finished oil | ..... | ..... | ..... | ..... | 699 | ..... |
| **Coastwise-domestic—** | | | | | | |
| Fuel oil | 69,980 | 9,997 | 60,218 | 8,603 | 5,523,048 | 5,418,447 |
| Diesel and gas oil | 20,177 | 2,882 | 26,905 | 3,844 | 1,128,977 | 1,352,472 |
| Gasoline | 101,606 | 14,515 | 120,406 | 17,201 | 6,874,137 | 6,753,708 |
| Kerosene | 18,994 | 2,713 | 20,167 | 2,881 | 811,042 | 542,778 |

to the Ford zone was recompleted pumping 226 bbl. of clean 28.9-gravity oil per day from 5,716 ft. This well had been deepened from 3,615 ft.

The tideland accumulation in the Long Beach Harbor section of the Wilmington field and about which the federal Government seems to be hot and bothered contributed two additional new wells this week. Both of these new wells were completed by Long Beach Oil Development Co. for account of the city of Long Beach in accordance with the municipality's award made several months ago. These wells become the city's property as soon as completed and are subject only to an allowance for operation and maintenance and return of capital invested by the operating company. No. 5-W was completed flowing 280 bbl. of 20.8-gravity oil per day through a 24/64-in. bean from the upper Terminal zone and 324 bbl. of clean 29.8-gravity oil daily through an 18/64-in. bean from the lower terminal zone. Drilling operations were concluded at 3,925 ft. No. 7-W, unlike No. 5-W which was a multiple zone completion, was completed in only the lower Terminal zone although the upper Terminal zone can be produced if desired. No. 7-W was completed flowing 235 bbl. of clean 29.5-gravity oil per day through a 16/64-in. bean from 4,034 ft.

## Montebello

The Montebello field, where operators are exploiting a structure in the west end of the field, is still the most active district in the state from a drilling standpoint and will probably retain this distinction for several months as there are still 40 incompleted drilling wells under way or former upper-zone producers being deepened to La Merced zone. The actual outer limits of production have not been determined, although several wells have found evidences that the productive limits can not be located very far away from present work. Six drilling wells tested wet this week and had to be recemented. Since most of these wells are around the limits of production this may be the tip-off that edgewater may have been encountered. No move has yet been made to exploit the deep zone known to exist below La Merced zone.

Four wells were completed in the west end last week. No. 36 Monterey of J. E. Mabee Co. was completed flowing 908 bbl. of 36.2-gravity oil cutting 1 per cent through two 32/64-in. beans along with 1,100,000 cu. ft. of gas per day from La Merced zone with bottom of the hole at 7,750 ft.

No. 2 Coffman of Graham-Loftus Oil Corp. completed in La Merced zone at 7,652 ft., came in doing 570 bbl. of 37.1-gravity oil and 3,850,000 cu. ft. of gas per day through a 32/64-in. bean behind a tubing pressure of 500 lb. and a casing pressure of 800 lb. The hole was finished with a string of 7-in. casing cemented at 7,547 ft. and then gun-perforated opposite the gas zone. Bottom of the hole was finished with 115 ft. of 5½-in. liner landed at 7,650 ft. and perforated at 7,545-7,650 ft. and 7,640 ft. of 2½-in. tubing with valve and packer. No. 2-16 Cowan of Caminol Co., Ltd., total depth 7,640 ft., started off flowing 1,020 bbl. of 35.9-gravity oil through two 1-in. beans along with 3,800,000 cu. ft. of wet gas daily.

No. 1 Long of York Oil Co., near Maple and Beverly Boulevard, and south of Beverly, was finished flowing 601 bbl. of 36.5-gravity oil and 550,000 cu. ft. of gas per day from the La Merced zone with bottom at 7,656 ft. Production was coming through two 1-in. beans under a steady pressure. Inasmuch as the court injunction prohibiting gas waste in the Montebello field does not apply during the completion period it has become the custom to flow new wells wide open until they get under way after which they are pinched in to reduce gas production. Completion periods are comparatively short due to two reasons. One reason is to keep within normal practice and the other reason is because as a rule wells in this field come in quickly and reach top rate within a short time.

## Coalinga District

No. 64-30-B of Wilshire Annex Oil Co., about midway between the Northeast and Southeast Coalinga fields of Fresno County in the San Joaquin Valley, which looked very good a few weeks ago before mechanical trouble developed, has failed to respond to several days of swabbing and bailing. The well cored an oil sand just above the bottom of the hole at 8,383 ft. but the production test made early this week indicated the well did not have sufficient pressure to result in a natural flow. This well is an important test inasmuch as it may have an important effect on future drilling at the south end of the Northeast Coalinga field and at the north end of the Southeast Coalinga field. South of the Southeast Coalinga field and north of an outpost recently drilled and abandoned by E. A. Parkford, Universal Consolidated Oil Co. has just passed the 6,000-ft. level in No. 81-24-C in Section 24-20-15, and should reach the point at which the Gatchell sand should be found within another week or 10 days. This well is being drilled on the assumption that the thin streak of Gatchell zone found by Parkford should thicken toward the north sufficiently to make a commercial well.

Drilling operations in the Southeast Coalinga field are being maintained at a normal rate. There are still several hundred acres waiting for the drill, but operators do not seem to be in any hurry to start work on inside locations. During the past week, Texas Co. completed No. 3 Exeter fee in Section 6-20-16, in the northern part of the Southeast Coalinga field flowing at the rate of 1,840 bbl. of 32.2-gravity oil and 1,300,000 cu. ft. of gas per day from the Gatchell zone at 8,220 ft. New wells are not allowed to produce for more than a few hours following completion. Rig is up for No. 4 Exeter fee and present plans call for immediate work. Up in the Northeast Coalinga field, Union Oil Co. has two wells headed down to the Gatchell zone and Superior Oil Co., Standard Oil Co. and Amerada Petroleum Corp. are working on one each.

## Greeley—Canal

General Petroleum Corp. may have found a new productive area between the Greeley and Rio Bravo fields in Kern County although it is not at all improbable that this company's No. 1 Sullivan in Section 12-29-25, may be a northwestern outpost in the Greeley field. It cored an excellent oil sand at 11,327-86 ft. and was being cored ahead and at last report was still in the pay. The company landed a 6⅝-in. water string at 11,327 ft. and on the formation test with a 5,000-ft. water-cushion water reached the surface in 26 minutes followed by water in 40 minutes. The well flowed clean crude oil for 3 minutes and after the valve was closed it required 59 minutes to exhaust the head in the drill pipe. Following the test the company resumed coring. North of No. 1 Sullivan, General Petroleum has completed rig for No. 1 Farrand in Section 12-29-25. No. 1 Sullivan looks almost certain of showing large production upon being tested out within the next week or 10 days. In the Canal field of Kern County, Ohio Oil Co. completed No. 15-E Kern County Land in Section 14-30-25, flowing 1,360 bbl. of clean 32.4-gravity oil and 1,800,000 cu. ft. of gas per day

*(Continued on Page 235)*


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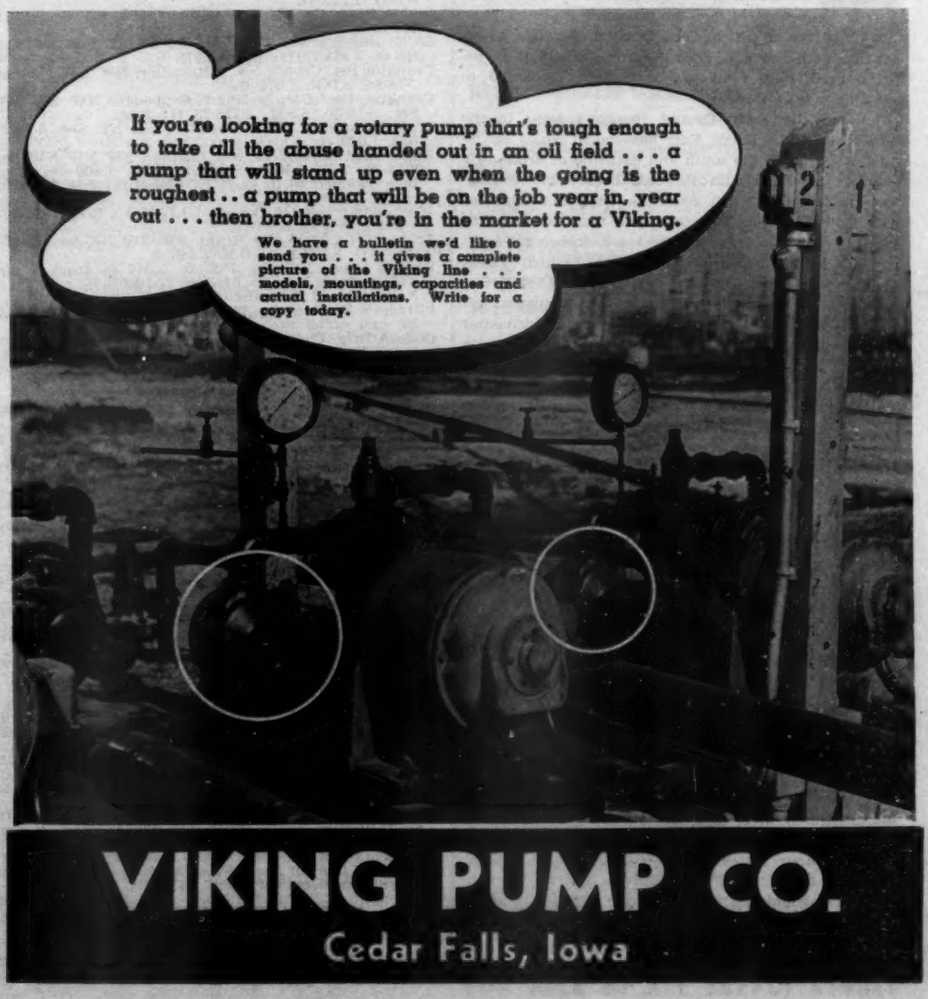
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# Rocky Mountain Area

By
T. R. INGRAM

# Increased Work in Northern Area; Lance Creek Big Wells

DENVER, Colo., Nov. 13. — The northern Rocky Mountain area showed a considerable increase in drilling operations the past week. Principal completions were in the Lance Creek field, in Wyoming, of which there were three with two near completions. The Ohio Oil Co.'s No. 13 Lamb flowed 95 bbl. an hour from the Leo sand; the Continental Oil Co.'s No. 4-B Diehlman made 1,728 bbl. initially through the tubing in the Leo sand, and the Ohio Oil Co.'s No. 7 Leo swabbed 232 bbl. initially from the Sundance.

The Glentop Exploration Co.'s wildcat in Platte County reports a show of oil at shallow depth and will test. The Mountain Fuel Supply Co.'s No. 1 Mosey, Middle Baxter basin, was a small gas well. The Cut Bank field in Montana had two completions, and Kevin-Sunburst scored three.

New operations included a test on the south end of the Berthoud dome in Colorado by L. R. Steele; a wildcat on the Iron Springs dome in Moffat County; an edge well at Rock Creek, in Wyoming, in the Ohio Oil Co.'s No. 15 Harrison & Cooper, a shallow test in Fremont County by the Yellowstone Oil Co.; another location on Cole Creek, by the General Petroleum Corp.; two wells in Cut Bank, Montana, and one new operation in Kevin-Sunburst; and an important test in northeastern Arizona.

Holding the attention in southeastern New Mexico during the week was the Vacuum pool in central Lea County. Seven new completions were reported from this area, five of which were Texas Co.'s wells. New work in both Lea and Eddy counties was slightly below normal, only four new tests being recorded in Lea and two in Eddy.

Both of the Eddy County locations were in the Loco Hills pool. R. W. Fair has staked No. 3 Brainard 2,310 ft. from the south and east line of Section 10-18s-29e, while Franklin Petroleum Co. No. 2-B Ballard was located 2,310 ft. from the north and east lines of Section 1-18s-29e. Only one well was completed in the Loco Hills pool during the week, it being Franklin Petroleum Co.'s No. 3-A Ballard, which gaged 500 bbl. daily from pay sand drilled from 2,765-95 ft.

Activity continued in the recently discovered oil pool in the western part of Lea County. Continental Oil Co. and others No. 1 Robert C. Langston, ¾ mile southeast of Frank Farley and others' (now Westlea Oil Co.) No. 1-A Texas Co.-State, discovery well in the pool, was drilling below 145 ft. as the week closed. It is in the C SE SW Section 15-20s-32e.

## SOUTHEAST NEW MEXICO COMPLETIONS

### Eddy County

In the Loco Hills pool, Franklin Petroleum Corp.'s No. 2-B Ballard, Section 1-18-29, flowed 500 bbl. daily through open casing from pay logged from 2,765-95 ft., total depth.

### Lea County

In the Mattix poot, Skelly Oil Co.'s No. 1 J. W. Sherrel, Section 31-23-37, flowed 137 bbl. daily through ½-in. choke on 2-in. tubing from pay from 3,494 to 3,540 ft. after 206-qt. shot. Skelly Oil Co.'s No. 2-M State, flowed 333 bbl. daily after 336-qt. shot in the pay section from 3,462 to 3,541 ft.

In the Eunice area, Gulf Oil Corp. No. 3-B Mattern, Section 31-21-37, flowed 152 bbl. daily through ½-in. choke from pay at 3,555-4,000 ft., total depth.

In the Hardy area, Magnolia Petroleum Co.'s No. 5 Brunson-Argo Oil Corp., Section 10-22-37, flowed 187 bbl. in 18 hours after a 125-qt. shot in pay section from 3,650 to 3,721 ft.

In the Vacuum pool, Humble Oil & Refining Co.'s No. 10-K State, Section 28-17-35, flowed 43 bbl. daily for 6 hours from pay logged from 4,153 to 4,640 ft.

Republic Production Co.'s No. 4-B State, Section 32-17-35, flowed 27 bbl. hourly for 6 hours from pay logged from 4,351 to 4,550 ft.

Texas Co.'s No. 5-R State, Section 6-18-35, flowed 333 bbl. in 6 hours through open 2-in. tubing from pay from 4,250 to 4,640 ft.

Texas Co.'s No. 3-L State, Section 1-18-34, flowed 261 bbl. in 6 hours from pay logged from 4,270 to 4,714 ft.

Texas Co.'s No. 2-M State, Section 1-18-34, flowed 103 bbl. in 6 hours from pay logged from 4,275 to 4,714 ft.

Texas Co.'s No. 4-R State, Section 2-18-34, flowed 164 bbl. in 6 hours from pay from 4,273 to 4,714 ft.

Texas Co.'s No. 2-X State, Section 3-18-34, flowed 80 bbl. in 6 hours from pay logged from 4,195 to 4,700 ft.

#### Eddy County

Carper Drlg. Co.'s No. 4 Robinson, SE SE SW Sec. 25-16-31. T.D. 4,025 ft.; tstg. on pmp.
G. R. Burke's No. 1 State, NE NE NW Sec. 36-16-24. S.D.O. 1,900 ft.
B. H. Nolem's No. 1 Iles, SE SE SE Sec. 17-16-29. Tstg. 1,803-19 ft.; est. 80 B.O.P.D.; pmpg.; tstg. 1,824 ft.
Saunders' No. 1 Murdock, NW NW SW Sec. 4-18-29. Drlg. 1,653 ft.
Artesia Drlg. Co.'s No. 1 Hoffman, SE SE SE Sec. 14-17-24. Drlg. 570 ft.
J. R. Cones et al's No. 1 Saunders, SE SE NW Sec. 13-17-27. S.O. 505 ft.; S.D.O. 600 ft.
Danciger O. & R. Co.'s No. 5-A Turner, C N½ NW NW Sec. 19-17-31. S.O.G. 3,409-15 ft.; tstg.
J. E. Hughes' No. 3 Brooks, NE NW NW Sec. 19-17-28. S.D.O. 2,222 ft.
Plains Prod. Co.'s No. 1 Massie, C SW SW Sec. 27-18-29. Drlg. 2,862 ft.
L. E. Elliott's No. 1 Elliott, SE SE SE Sec. 24-18-29. S.S.O. 3.255-75 ft.; drlg. 3,478 ft.
Franklin Pet. Corp.'s No. 1 Masteller, NW NW NE Sec. 7-18-30. S.D.R. 1,675 ft.
Franklin Pet. Corp.'s No. 1 Cappedge, NW SW NW Sec. 5-18-30. S.S.G. 3,118-23 ft.; tstg.
E. S. McAuliff's No. 1 Coates, C SE NE Sec. 3-18-23. S.D. 1,079 ft.
Underwood & Sanders' No. 2 Miller, SW NW NW Sec. 4-18-29. T.D. 2,405 ft.; milling csg. 1,800 ft.; jnkd. hole; skidded 50 ft. east; T.D. 2,660 ft.; P.B. 2,635 ft.; tstg.
J. W. Elliott's No. 1 Cannon (O.W.D.D.), C SW SE Sec. 4-19-30. Drlg. 2,478 ft.
Trojan Oil Co.'s No. 1 Grant, SW SW NE Sec. 33-20s-25e. S.O. 1,530 ft.; S.D.R. 1,580 ft.
Dodson Drlg. Co.'s No. 1 State, 2,310 ft. from N and 330 ft. from E lines of Sec. 17-16-29. ½ mile N of Nolen's No. 1 Iles discovery well. Spdg.
Pittman's No. 1 State, 330 ft. from SW cor. Sec. 17-16-29; east offset to Nolen pool opener. C.&P.
Dodson Drlg. Co.'s No. 1 A. H. McElreath, 330 ft. from S and W lines of Sec. 3-16-29, 2½ miles NE of Nolen pool opener. Spdg.

#### Chaves County

G. H. Cowden's No. 1 Brunson, 330 ft. N and W lines. Sec. 27-9s-30e. C.&P.
Caudill & French's No. 1-A Smith (O.W.D.D.), Sec. 1-4-29. S.D.R. 3,686 ft.
E. J. Fisher's No. 1 Hill, CSL S½ Sec. 8-15-25. S.D.O. 850 ft.
Tarkenton Bros.' No. 1 Peters, SE SE NW Sec. 33-11-25. S.S.O. 1,280-85 ft.; S.D.O. 1,374 ft.
Western Minerals, Inc.'s No. 1 Dow, C SW NW Sec. 27-10-30. S.O. 3,920-25 ft.; S.I. 4,090 ft.

#### Dona Ana County

Picacho O. & G. Co.'s No. 12 Armstrong, Sec. 15-23s-1w. W.O. csg. 2,620 ft.
Slack & Mahres' No. 1 Simmons, Sec. 35-22s-5e. S.D. 2,785 ft., T.D.; repairs.

#### Luna County

O. D. Berry's No. 1 Berry, SE SE SW Sec. 33-22s-10w. S.D.O. 1,000 ft.

#### Lea County

Frank Farley's No. 1-A State, Sec. 18-21s-30e. Prep. drill plug; sat. 2,629-31 ft.; new pool opener; flwd. 1,000 B.O. in 18 hrs.; est. 1,500 B.O.P.D.; S.I. for storage.
Wilson Oil Co.'s No. 1 Shell-State, C NE SW Sec. 7-21-35. T.D. 3,736 ft.; flwd. 51 B.O.P.D.; rng. 7-in. 3,636 ft.
Argo Oil Corp.'s No. 1 Texas Co.-State, west offset to Westlea Oil Co. pool opener. Drlg. 1,142 ft.
Westlea Oil Co.'s No. 1 Texas Co.-Cleveland, 2,310 ft. S of Westlea pool opener and 330 ft. from N and 1,980 ft. from W line of Sec. 21-20s-32e. Drlg. 910 ft.
Continental Oil Co.'s No. 1-A-15 Langston, 660 ft. from S and W lines of Sec. 15-20s-32e, ¾ mile southeast of Westlea pool opener. Drlg. 145 ft.

## NORTHWEST NEW MEXICO

#### San Juan County

Continental Oil Co.'s No. 99 Rattlesnake, SW SE SW Sec. 12-29n-19w. S.D. 600 ft.
Kutz Deep Test, Inc.'s No. 7 Govt., C NW NW Sec. 28-28n-10w. Drlg. 450 ft.
Congress Oil Co.'s No. 2 Govt., Sec. 18-28n-11w. Drlg. 1,890 ft.
Angel Peak Oil Co.'s No. 8 Govt., C NW SW Sec. 13-28n-11w. T.D. 1,420 ft.; R.U. new rig.
Continental Oil Co.'s No. 100 Rattlesnake, NE NW NE Sec. 2-29n-19w. Drlg. r.b. 5,020 ft.

#### Bernalillo County

Norins Realty Co., Inc.'s No. 2 North Albuquerque, NE SE NW Sec. 19-11n-4e. S.D. 4,600 ft.

#### San Miguel County

Southwest Drlg., Inc.'s No. 1 Conchas, NW NE Sec. 34-17n-21e. Drlg. 2,150 ft.

#### Valencia County

C. A. Grober et al's No. 1 Fuqua, NE NE Sec. 19-5n-3e. S.D. 3,850 ft. to run 6⅝-in.

## COLORADO

#### Adams County

Derby Dome O. & G. Co.'s No. 2 Baxter, C SE SW Sec. 2-3s-66w. T.D. 62 ft.; R.U. to res.

### Boulder County

The test well on the El Dorado structure recently drilled to 6,381 ft. by the Continental Oil Co. in its No. 1 Borra, SE NE SW Section 5-1s-69w, may be carried down to the Dakota sands by other interests, according to H. L. Garner, geologist, of Denver, who with his associates blocked the acreage and turned it to the Continental company. The test was drilled through the Hygiene formation by the Continental company, but did not go to the Dakota. At 6,381 ft. the company suspended drilling and turned the well and leases back to the owners. It was left in shape so that little additional work will be required to drill out the plugs and continue to the lower sand. The hole now stands with the 13⅞-in. cemented at 420 ft. and 6,381 ft. of 9⅞-in. open hole filled with heavy mud, and considerable equipment on the ground. The structure was not discovered through geophysical methods as reported in The Oil and Gas Journal, according to Mr. Garner, but on the contrary he spent 2 months in a detailed plane-table surface and subsurface survey, and subsequently it was turned to the Continental after its geological department had in a similar manner checked the structure. The Hygiene is not productive in this area, and the Dakota series, which was not reached in this test, is the normal objective. Mr. Garner's interpretation of the log of the well places it at least 150 ft. higher than the Ohio Oil Co. well drilled several years ago 3 miles to the northeast, which showed some saturation, and he expresses the opinion that the test will not be conclusive until it is carried to the lower horizons, and present plans have that objective in view. Mr. Garner formerly was consulting geologist for the General Petroleum Corp., and other well-known California companies.

#### Custer County

Henry Donnelly's No. 1 Hodge, SE NE Sec. 26-21s-69w. S.D. 1,200 ft.

#### El Paso County

F. F. Hintze et al's No. 1 State, CEL SE SE Sec. 16-11s-60w. T.D. 385 ft.; U.R. 13½-in. for W.S.O.

#### Fremont County

T. E. Maloney's No. 1, SE NW Sec. 34-19s-69w. S.D. 1,850 ft. after rng. 1,300 ft. of 5⅝-in. and 550 ft. of 4½-in.
Waterville Oil Co.'s No. 2 Persons, CWL NE NE Sec. 17-19s-69w. S.D. 330 ft.

#### La Platte County

Nick Spatter's No. 1-X Bryce, C SW SW Sec. 31-33n-9w. T.D. 2,522 ft. in sd.; W.O. 5½-in.

### Larimer County

L. R. Steele and others will drill down their No. 1 Bund at the south end of the Berthoud structure as a test for oil. It was started as a water well and at present depth of 700 ft. it is moving in heavier machine to go to the Muddy sand.
Continental Oil Co.'s No. 1 Meyers, SW SE SW Sec. 19-

8n-68w. T.D. 5,206 ft.; P.B. to 4,686 ft.; shot with 20 qt. at 4,464-4,686 ft.; W.O. pmp. equip.
L. R. Steele et al's No. 1 Bund, NE SW Sec. 7-3n-69w. T.D. 700 ft.; M.I. National mch. to D.D.

**Las Animas County**

Hulme-Johnston-Allison's No. 1 Azar, SE SE NW Sec. 27-34n-58w. Drlg. reddish sd. at 2,180 ft.

### Moffat County

The Great Divide Petroleum Co.'s No. 1 Stanley Wyatt, SE¼ Section 6-9n-92w, Iron Springs district, is spudding in for a 2,000-ft. test of beds in the Wasatch formation. Contract was let to J. H. Farington. Location is about 3 miles east and a little north of the Iron Springs Petroleum Co.'s No. 1 Beckett, SE cor. Section 9-9n-93w, which has some materials on the ground. Both companies are composed of Utah people and both locations were made by John B. Crapo, of Vernal, Utah, and Ed H. Watson, of Salt Lake City.

Great Divide Pet. Co.'s No. 1 Wyatt, SE¼ Sec. 6-9n-92w. Spdg. (first report).
Cooperative O. & G. Co.'s No. 1 Gossard, CWL E½ E½ Sec. 29-5n-93w. Spd. and S.D.; will skid mch. and bld. standard rig.
Steamboat Springs Synd.'s No. 1 Sutton, NE NE SW Sec. 1-5n-96w. S.D. 2,125 ft. for csg.; H.F. brackish wtr. in sd. (probably Sundance); T.D. 1,780 ft.

**Park County**

South Park Oil Co.'s No. 1 Lemar, NE NE SE Sec. 34-11s-75w. Drlg. below 7,072 ft.

**Rio Blanco County**

Texas Co.-California Co.'s No. 3 Unit, NE NE NE Sec. 27-3n-94w. Drlg. 714 ft.
Buford Oil Co.'s No. 1 Govt., C SW SW Sec. 16-1n-91w. T.D. 4,070 ft.; fsg. bit.

**Routt County**

L. C. Craig and L. C. Moore's No. 1-X Irwin, C SW NE Sec. 33-7n-85w. Drlg. 2,090 ft.

### Washington County

Thurman Oil Trust's No. 1 Ruby, Thurman district, lost the hole at 140 ft. when it was unable to recover bit. Portable rotary was moved in for new hole which has spudded and is drilling below 150 ft.

Thurman Oil Trust's No. 1 Ruby, NW NW SW Sec. 3-5s-52w. Drlg. 150 ft. in new hole.

## WYOMING

**Big Horn County**

Yale Oil Corp.'s No. 2 Jones, Lot 59, approx. CEL NE SE Sec. 29-56n-97w. Drlg. 1,715 ft.; 10¾-in. cmtd. 1,104 ft.

### Carbon County

The Ohio Oil Co. has released location for its No. 15 Harrison & Cooper in the Rock Creek field. It is an outside well on the southeast, being a diagonal offset on the southeast to No. 14 Harrison & Cooper which was completed in the Sundance for 400 bbl. initially.

Ohio Oil Co.'s No. 15 Harrison & Cooper, SE NE NW Sec. 2-19n-78w. R.U.R. (first report).
Frank M. Johnston's No. 1 Govt., C SE SE Sec. 22-24n-88w. Drlg. 875 ft.
Martin & Gaylord's No. 1 Horne Bros., CNL NW SW Sec. 22-22n-78w. T.D. 990 ft.; U.R. 6⅝-in. to set on bttm.
Ohio Oil Co.'s No. 1 University, SW SW SW Sec. 26-20n-78w. T.D. 3,579 ft.; cmtd. 5-in. at 3,378 ft.; C.O.
Albert Dev. Synd.'s No. 1 Boeke, SW NW Sec. 18-25n-79w. Drlg. 360 ft.
Producers Oil Co.'s No. 1 Lake Valley, CNL Sec. 14-20n-88w. S.D. 3,610 ft.

**Converse County**

New Era Fuel Co.'s No. 1 Pestal, SE NE NE Sec. 32-32n-69w. Drlg. 565 ft.; S.O. 535 ft.; 8¼-in. cmtd. 555 ft.
Blue Ridge Oil Co.'s No. 1 Prokesh, SW NW SE Sec. 29-32n-69w. Drlg. 600 ft.; carrying 8¼-in. at 563 ft.

### Fremont County

The Yellowstone Oil Co.'s No. 6 Government, in the Shoshoni district, has spudded in a 12½-in. hole to go to 1,500 ft. The location is ¾ mile east of Hall & Olinger's No. 5 Government which was abandoned at 1,000 ft. A series of core holes are being drilled primarily to work out subsurface structure, but some of them are being carried down to a shallow sand which has shown some oil saturation.

Yellowstone Oil Co.'s No. 6 Govt., C NE NE Sec. 33-38n-93w. Spdg. (first report).
Sinclair-Wyoming Oil Co.'s No. 11 Sand Draw Unit, CSL NE NE Sec. 15-32n-95w. Drlg. 4,164 ft.; T. Lakota 4,139 ft.; cmtd. 7-in. 4,140 ft.
Consolidated Oil Properties' No. 3 Ewart, C SW SE Sec. 16-1n-1w. Drlg. in Embar 1,420 ft.

**Hot Springs County**

John W. Selby's No. 1 Kyne, SW NW Sec. 22-43n-92w. T.D. 409 ft.; rng. 8¼-in. to set on bttm.
J. W. Bales' No. 1 Govt., CWL NW SE Sec. 21-42n-90w. Drlg. 465 ft.

**Lincoln County**

H. C. Harris et al's No. 1 Govt., SE NW NW Sec. 23-21n-117w. Drlg. 2,390 ft.

### Natrona County

The General Petroleum Corp. has released location for No. 1-21-G on the Cole Creek structure, ½ mile northwest of its discovery well in the Dakota-Lakota. This is the third well drilled on the structure. The second, a mile to the north of the discovery, went to the Sundance without results.

General Pet. Corp.'s No. 1-21-G, NW NW NW Sec. 21-35n-77w. Loc. (first report).
Iron Creek Oil Co.'s No. 1, CWL SW NW Sec. 11-32n-82w. T.D. 721 ft.; trying to drill by lost bit (first report; Iron Creek dist.).
Continental Oil Co.'s No. 1 McGrath, C NW SW Sec. 15-34n-78w. Drlg. sd. and sdy. sh. 6,533 ft.; unable to obtain D.S. tst. in Muddy sd.; Lakota T. 6,418 ft. was dry.
Connelly Drlg. Co.'s No. 1 State, SW SW NW Sec. 36-36n-81w. Drlg. below 1,300 ft.
Summit Oil Co.'s No. 2 Govt., NW NE NE Sec. 21-33n-80w. S.D. 960 ft.

### Niobrara County

Lance Creek had three completions, all inside wells, two near completions, and no new operations.

The Ohio Oil Co.'s No. 13 Lamb-Acct. 1, NW SE NE Section 5-35n-65w, flowed at the rate of 95 bbl. an hour from the Leo sand at 5,487 ft., total depth. It had the top of the upper bench at 5,270 ft., and the second bench at 5,449-80 ft. The 7-in. was set at 5,268 ft. and the rotary table elevation is 4,455 ft.

The Continental Oil Co.'s No. 4-B Diehlman, SW SW NW Section 8-35n-65w, was completed at 5,544 ft. for an initial production of 1,728 bbl. in 24 hours through the tubing from the Lea sand, topped at 5,512 ft. after acidizing. The 7-in. was cemented at 5,507 ft.

The Ohio Oil Co.'s No. 7 Leo-O.P.C.-16, NE NE SW Section 35-36n-65w, swabbed 232 bbl. in 24 hours through the tubing from the Sundance sand at 4,356 ft., total depth. Top of the basal Sundance was at 4,413 ft. It is between the same company's No. 1 Leo-7 and No. 6 Leo-16, all three wells being on the extreme eastern edge of the developed area and in a district some distance east of the principal Sundance production.

The Utah Oil Refining Co.'s 438-mile pipe line from Fort Laramie to Salt Lake City was completed November 8 and it is now being filled with oil. It will be another week before the oil reaches its western terminal. Booster stations have not yet been completed. The line is described by the builders as traversing the most difficult terrain of any ever laid in the United States.

The Continental Oil Co.'s No. 4 Apex-1, NW NE NE


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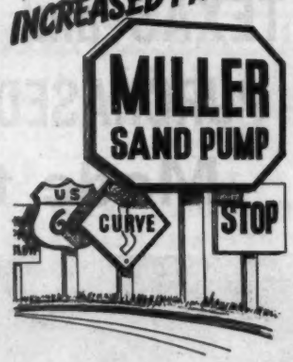

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Section 34-36n-65w, swabbed and flowed 135 bbl. in 12 hours through the tubing at 5,330 ft., total depth, from the Leo sand, and is a near completion.

The Continental Oil Co.'s No. 5 Apex-3, SE NE SW Section 34-36n-65w, swabbed 172 bbl. through the 2-in. tubing at 5,460 ft., total depth, after acidizing with 1,000 gal. It was then acidized with 2,000 gal., and is swabbing and circulating.

Continental Oil Co.'s No. 5-B Diehlman, NW SE NE Sec. 7-35n-65w. R.U.R.

Minnelusa Oil Corp.-MacKinnie O. & D. Co.'s No. 7 Thompson, SE NW NE Sec. 7-35n-65w. Loc.

Argo Oil Co.'s No. 1 Ong, SE SE SW Sec. 31-36n-65w. Drlg. 2,268 ft.

A. B. Cobb & Co.'s No. 5 Novick, NE NE NW Sec. 6-35n-65w. Drlg. 1,685 ft.

Ohio Oil Co.'s No. 13 Carrie Putnam, C NW NW Sec. 4-35n-65w. Drk.; W.O. rig.

Continental Oil Co.'s No. 6 Sam Joss, NW NW NE Sec. 6-35n-65w. Drlg. sh. 3,208 ft.

Continental Oil Co.'s No. 6-A Diehlman, NW NE NE Sec. 7-35n-65w. Cmtd. 13⅜-in. at 303 ft.; W.O.C.

Continental Oil Co.'s No. 5-A Diehlman, SE NW NW Sec. 8-35n-65w. M.I.M.

H. D. Moore et al's No. 1 Berggren, SE NW Sec. 23-35n-63w. T.D. 2,242 ft.; T. Leo 2,228 ft.; rng. 7-in.

Minnelusa Oil Corp.-MacKinnie Oil & Drlg. Co.'s No. 1 Thompson, NE NW NE Sec. 7-35n-65w. Drlg. 5,125 ft.; red marker 5,123 ft.

Minnelusa Oil Corp.-MacKinnie Oil & Drlg. Co.'s No. 6 Thompson, NE NW SE Sec. 7-35n-65w. Drlg. 5,418 ft.; red marker 5,410 ft.

Argo Oil Co.'s No. 11-B Elliott, NE NE SW Sec. 5-35n-65w. Cg. 5,207 ft.; cmtd. 7-in. 5,280 ft.; red marker 5,142 ft.

C. L. Price's No. 2 Lamb, SE NW NW Sec. 7-35n-65w. Cg. below 5,406 ft.

A. B. Cobb's No. 4 Novick, SE SE SW Sec. 6-35n-65w. T.D. 5,380 ft.; C.O. to test again.

F. F. Hintze et al's No. 1 Wright-Govt., C NW SE Sec. 30-36n-63w. T.D. 4,964 ft.; cmtd. 7-in. at 4,617 ft. and perf. to test.

Fall River Prod. & Roy. Co.'s No. 1 Govt., CSL SE SE Sec. 35-40n-61w. T.D. 2,662 ft.; good S.O.; prep to run 8-in.

### Park County

Stanolind O. & G. Co.'s No. 1 Govt., NE NE NE Sec. 2-47n-100w. T.D. 1,872 ft.; tstd. 9,000,000 cu. ft. gas; P.B. to 1,710 ft. to S.O.W.

Mule Creek Oil Co.'s No. 1, Lot 51, Sec. 9-46n-101w. Drlg. 240 ft.

### Platte County

The Glentop Exploration Co.'s No. 1 Militin, in the Glendo district, is reported to have a good show of light oil at 626 ft., a few inches in a formation in the top of the Hartville (Pennsylvanian) series. The 8¼-in. was underreamed and is being set on bottom to make a water shutoff. The Pennsylvanian lies immediately beneath an overlay of White River (Tertiary) and was topped at 546 ft. and followed by water at 550 ft. Following the shutoff the hole will be drilled deeper into the formation to see what it amounts to.

Glentop Exploration Co.'s No. 1 Militin, NE SE NE Sec. 18-30n-67w. T.D. 626 ft.; setting 8¼-in. on bttm. for W.S.O.

### Sublette County

North La Barge Oil Co.'s No. 2 Govt., SW NE NE Sec. 28-27n-113w. Drlg. 200 ft. (form. Minton et al).

Wyoming Pet. Corp.'s No. 1 Budd, C NE NE Sec. 10-29n-113w. Drlg. 2,869 ft.

Texas Co.'s No. 1-D, SW NE NE Sec. 27-27n-113w. Cg. 1,020 ft.

Wyoming Pet. Corp.'s No. 2 Govt., SE cor. Sec. 3-29n-113w. Spdg.

California Co.'s No. 1 Unit 1, C SW NE Sec. 14-31n-109w. T.D. 10,003 ft.; cmtd. 7-in. at 8,550 ft.; tstg.

### Sweetwater County

The Mountain Fuel Supply Co.'s No. 1 G. H. Mosey, NW cor. Section 18-18n-104w, Middle Baxter basin, was completed at 2,610 ft., total depth, for 375,000 cu. ft. of gas per day. It is producing through perforated casing set on bottom.

Sinclair-Wyoming Oil Co.'s No. 88-A, NW SE SW Sec. 11-26n-90w. Drlg. 583 ft.; 10¾-in. at 58 ft.

Sinclair-Wyoming Oil Co.'s No. 87-A, SW SE SE Sec. 3-26n-90w. T.D. 2,134 ft.; cmtd. 7-in. at 2,131 ft.; R.U.C.T.

Wyoming-Calif. Pet. Co.'s No. 2 Govt., CWL NW SW Sec. 24-17n-104w. Drlg. 2,861 ft.

### Uinta County

Stove Creek Oil Co.'s No. 1 Govt., NE SW NE Sec. 26-14n-119w. Drlg. 1,690 ft.

### Weston County

John Brorphy's No. 1 Hansen, NW NE NW Sec. 13-44n-63w. M.I.M.

Gose Oil Synd.'s No. 1, NE cor. Sec. 28-47n-63w. Cmtd. 4½-in. at 4,918 ft.

Hugh Updike's No. 4, CEL NE NE Sec. 36-46n-64w. Drlg. below 1,000 ft.

Bruce C. Teeter's No. 1 State, SW SW SE Sec. 36-32n-61w. Recmtd. 8¼-in. at 1,860 ft.

## MONTANA

A statement of crude oil produced and refined in Montana by fields from the discovery date to June 30, 1939, prepared by the Oil Conservation Board, shows a total production of 72,427,645 bbl. Of that quantity, Kevin-Sunburst produced 34,488,089 bbl., and Cut Bank was second with 14,990,818 bbl. Cat Creek was third with a total of 14,176,790 bbl. Record of refining began with 1934 and from that year to June 30, 1939, there were 15,796,046 bbl. of Montana oil refined in the state, and 9,017,524 bbl. of Wyoming oil refined in Montana, a total of 24,813,570 bbl. refined in that state.

### Blaine County

Montana Gas Corp.'s No. 1 Bowes, NE SE NW Sec. 34-32n-19e. T.D. 795 ft.; prep to test.; S.G.

### Carbon County

Ohio Oil Co.'s No. 9 Souders, C NE SW Sec. 2-7s-21e. T.D. 5,498 ft.; sidetrkg. liner at 5,469 ft.

Minnelusa Oil Corp.-Henderson Prod. Co.'s No. 1-H-11-Elk-11, SE SE NW Sec. 35-9s-23e. Drlg. 1,992 ft.; 8⅝-in. cmtd. 1,793 ft.; S.O. in sd. at 1,989-92 ft.

R. C. Tarrant's No. 2 McKay, C SE NW Sec. 4-6s-18e. S.D. 2,290 ft.

R. C. Tarrant's No. 2 Heare, NW SE NW Sec. 14-6s-19e. Drlg. 1,400 ft.

Miracle Oil Co.'s No. 2 Govt., CWL NE SE Sec. 3-6s-23e. T.D. 2,381 ft.; C.O. 1,516 ft.

### Flathead County

Clark W. Beauchamp's No. 1, CSL SW SW Sec. 2-27n-20e. S.D. 150 ft.; to M.I. rig.

### Fergus County

Baugham & Singley's No. 1 Skaggs, C NW SW Sec. 7-15n-20e. T.D. 1,090 ft.; rng. 3½-in. to bttm.

### Hill County

J. Gudgel's No. 1 Mancin, SE NE NW Sec. 19-37n-15e. Drlg. 1,160 ft.; S.G.

### Glacier County

Cut Bank reported two completions and two new operations.

The Texas Co.'s No. 2 J. Bonnet, C SW SE Section 8-32n-5w, swabbed 131 bbl. first 24 hours at 2,961 ft., total depth, from the lower Cut Bank at 2,944-58 ft. Main pay was at 2,947-56 ft.

The Glacier Production Co.'s No. 1 Stott, C SE NW Section 34-33n-5w, located nearly a mile south and east of the nearest producers, in the southeastern part of the field, swabbed 139 bbl. of water and 22 bbl. of oil first 24 hours at 3,105 ft., total depth, and is trying to shut off water. The Sunburst at 2,990-3,002 ft. was dry. The upper Cut Bank was at 3,025-50 ft., and the lower Cut Bank, which also was the main pay, was at 3,090-3,100 ft.

Cobb-Reagan's No. 4 Jackson, SW SW SE Sec. 5-32n-6w. R.U.R. (first report).

Texas Co.'s No. 2 State, C NE NE Sec. 36-34n-6w. Loc. (first report).

Texas Co.'s No. 3 Tweedy, CWL NW NE Sec. 21-35n-6w. Drlg. 350 ft.

Texas Co.'s No. 2 Lindquist, C SW SE Sec. 17-32n-5w. M.I.M.

M. R. Wagner, tr.'s No. 2-X Tribal-173, NE SE SE Sec. 12-32n-6w. Drlg. 455 ft.

Glacier Prod. Co.'s No. 2 Corrigeux, SW SW NW Sec. 21-33n-5w. Drlg. 1,070 ft.; Colo. 600 ft.

Glacier Prod. Co.'s No. 2 Rigney, C SE SW Sec. 35-36n-


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*General Offices:* Shreveport, La.

6w. Drlg. 1,435 ft.; Colo. 670 ft.; 10¾-in. 712 ft.
Nadeau Bros.' No. 6 Farmers State Bank, 440 ft. from EL, 1,320 ft. from NL, Sec. 17-33n-5w. Drlg. 2,525 ft.
R. C. Jeffries-Yukon Oil Co.'s No. 1 Clark, C SW NW Sec. 34-35n-6w. Drlg. 2,300 ft.
Texas Co.'s No. 9 Tribal-122, CSL SW SW Sec. 32-33n-5w. Drlg. 1,350 ft.; Colo. 560 ft.; 10¾-in. 586 ft.
Texas Co.'s No. 3 Hessler, C SE NW Sec. 20-33n-5w. Drlg. 220 ft.
A. B. Cobb-T. T. Co.'s No. 1 Bilstad, C NW SE Sec. 4-36n-5w. Cmtd. 7-in. at 2,814 ft.; crd. light sat. 2,825-43 ft. after blg. down 200 ft. O.I.H. in 3 hours; will D.D.
Texas Co.'s No. 1 Ammerman, CWL SW SE Sec. 26-36n-6w. Drlg. 2,695 ft.; W. at 2,520-45 ft.; S.O. with 8⅝-in. at 2,570 ft.

**Liberty County**

Coolidge & Coolidge's No. 1 Forseth, CEL SE NE Sec. 8-35n-4e. Drlg. 450 ft.

### Toole County

Leases on approximately 12,000 acres in four townships east of the Kevin-Sunburst field have been filed for record in Toole County by Harry Roe of Denver. They are principally in Townships 34 and 35 north, Ranges 1 and 2 east, with some in Township 36. Part of the block is in a district recently mapped by the United States Geological Survey showing some folds to the east of present production. Mr. Roe was with the old Midwest Refining Co. prior to its consolidation with the Standard Oil Co. of Indiana, and since then he has been identified with the field work of several prominent companies in the Rocky Mountain and Mid-Continent areas. Just what interests are represented in the block is not disclosed. It is believed that the district may be a gas area.

Kevin-Sunburst had three completions and one new operation. The best well was the G. & A. Oil Co.'s No. 14 Goeddertz, CEL SE SW Section 23-35n-3w, which is pumping 25 to 30 bbl. per day at 1,678 ft., total depth, which also is the top of the contact. It may be acidized later on.

A. Beardslee's No. 10 Swears, C SW NW Section 9-35n-2w, which found oil below a stratum of water, is pumping 20 bbl. of oil and 80 bbl. of water at 1,725 ft. after acidizing with 1,000 gal. It had water at 1,708 ft. and cemented the 6⅝-in. at 1,710 ft.

The Superior Oil Co.'s No. 12 Aronow, NW NW SW Section 12-35n-3w, is pumping 12 bbl. per day from the Sunburst sand at 1,510-35 ft.

Big West Oil Co.'s No. 14 Dahlquist, SE SW SW Sec. 21-35n-3w. Drlg. 760 ft. (first report).
Nepstad-Montgomery-Fargher's No. 2 Haugen, SE SE SW Sec. 2-35n-3w. Drlg. 960 ft.
A. E. Crumley & Son's No. 17 Fryberger, NE SE SW Sec. 24-35n-3w. Drlg. 1,080 ft.
Hannah-Porter's No. 2 Estenson, NE NW SE Sec. 19-33n-1w. S.D. 1,344 ft.; small S.G. in Sunburst 1,219-25 ft.
G. & A. Oil Co.'s No. 3 Aronow, CWL SE NE Sec. 16-35n-3w. T.D. 1,565 ft.; cmtd. 6⅝-in.
Henry Vander Pas' No. 3 Ward, NE SW NW Sec. 28-35n-3w. T.D. 1,655 ft.; cmtd. 6⅝-in.
S. T. Scotland's No. 3 McNamar, NW NE SW Sec. 29-35n-3w. Drlg. 1,563 ft.; S.G. in Sunburst 1,481-1,520 ft.
Frazer & Smith's No. 2 Van Note, NE SW NW Sec. 30-35n-2e. Drlg. 1,380 ft.
Coolidge & Coolidge's No. 1 Maley, SW NE SE Sec. 31-36n-1w. S.D. 100 ft.
Italo Pet. Corp.'s No. 1 Cornett, C SW NW Sec. 30-37n-3w. T.D. 2,690 ft.; 7-in. on bttm; tstg.; W.S.O.
Morton & Shaw's No. 1 Ellingson, NE NE NW Sec. 23-35n-3w. S.D. 400 ft.
Kippen O. & G. Co.'s No. 1 Solberg, SE SW NE Sec. 20-35n-3w. S.D. 1,904 ft.
W. E. Rice Co.'s No. 4 Kearns, Lse. 8, C W½ E½ SE Sec. 18-35n-2w. T.D. 1,570 ft.; rng. 6⅝-in.
C. L. Smith, Agt.'s No. 1 Govt., SW SE NW Sec. 13-35n-2w. S.D. 1,345 ft.
R. G. Parrent's No. 1 Holbrook, C NW NE Sec. 2-36n-3w. S.D. 1,370 ft.

**Yellowstone County**

Riverton Oil Co.'s No. 1 Fox, CEL NW NE Sec. 14-2n-23e. Drlg. 2,150 ft.

## UTAH

**Daggett County**

Mountain Fuel Supply Co.'s No. 4 Murphy, SW SE SW Sec. 21-3n-24e. Loc.

## SOUTH DAKOTA

**Harding County**

South Dakota State Roy. Co.'s No. 1 State, SW NW Sec. 35-18n-1e. Drlg. 6,760 ft.; C.O.

## ARIZONA

An important wildcat drilling on the Apache structure in the county of that name in northeastern Arizona is making considerable progress and is now running the 9⅛-in. casing to set at 2,000 ft. The 13-in. was set at 300 ft. and drilling is being done with a rotary. The operating company is the Franco-Arizona Oil Co., which was organized the past summer by Los Angeles people. The company is closely allied with the Franco-Wyoming Oil Co., which was prominent in the development of the Salt Creek field; the Franco-Central Oil Co., which has some operations in Kansas; and the McIlroy Ranch Co., which has 140,000 acres of University land in West Texas operated by the Gulf Oil Corp.

The Apache dome lies 40 miles south and a little east of Holbrook, and the test is in the SE SE NE Section 14-14n-26e. The hole started in the Moenkopi, and had 250 ft. of that formation, followed by 500 ft. of water-bearing Coconino sandstones. The structure was geologized by Everett S. Shaw, formerly with the Midwest Refining Co., but now in South America. He correlated the formations from the Salt River and contributary canons where about 2,000 ft. of formations were exposed. Then he ran his correlations north and east through two wells drilled in that area, both of which had showings, one of oil and the other of gas, clear through to the Rattlesnake dome in Northeast New Mexico, where the Continental Oil Co. found production in its No. 17 Rattlesnake at 6,767 ft. This horizon is the objective of the Apache well, which has an advantage of 3,500 ft. in drilling depths due to erosion down to the lower part of the Triassic.

### California Fields

*(Continued from Page 231)*

from the Stevens zone with bottom of the hole at 8,325 ft. No. 6-14-A Kern County Land of Shell Oil Co., Inc., in the Canal field has cored the Stevens zone and at 8,309 ft. has cemented a 7-in. water string at 8,160 ft. It should be the next completion listed in the Canal field.

### San Joaquin Basin

In the Kettleman North Dome field, Standard Oil Co. completed No. 85-21-Q in Section 21-22-18, flowing 1,610 bbl. of clean 34.6-gravity oil and 2,000,000 cu. ft. of gas per day from the Temblor with bottom of the hole at 8,035 ft. It is flowing through a 36/64-in. bean behind a tubing pressure of 1,000 lb. and a casing pressure of 1,150 lb. Top of the brown shale was cored at 5,191 ft.

In the North Belridge field of Kern County, Belridge Oil Co. completed No. 27-1 fee in Section 1-28-20, flowing 475 bbl. of clean 31.7-gravity oil and 9,265,000 cu. ft. of gas per day from the Wagonwheel zone with bottom of the hole at 8,450 ft. It was brought in flowing through a 96/64-in. bean but the size of the bean was substantially reduced following completion. The hole was finished with a 9-in. water string cemented at 8,115 ft. and 361 ft. of 5¾-in. liner landed at 8,450 ft. Top of the Belridge sand was cored at 8,143 ft.

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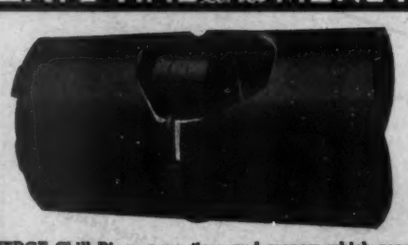

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# North and East Texas

By
D. H. STORMONT

# North Texas Pool Extended; Limestone County Discovery

WICHITA FALLS, Tex., Nov. 13.—Archer and Montague counties centered the majority of development and activity of the week in the North Texas district as deep wildcats throughout both counties drilled ahead toward the lower pay levels.

In the South Mankins deep Caddo-lime pool in northwestern Archer County, British American Oil Producing Co.'s No. 1 Hunter, northeast corner of McKinney & Williams Survey, Abstract 310, west offset to the discovery well in the pool, was drilling below 4,752 ft. in seeking deep Ordovician production. The test previously had topped an oil sand at 4,728 ft. at which depth oil rose 4,000 ft. in the hole.

New shallow oil pool for extreme southeastern Archer County was seen during the week when Shell Oil Co., Inc.'s No. 1 E. Colgan, test 4 miles north of the town of Megargel and in the southeast part of the J. F. Martin Survey, Abstract 276, cemented 4½-in. casing at 1,453 ft. on top of the Swastika sand. Saturation was drilled from 1,454 to 1,456 ft. and after plug was drilled it was deepened to 1,461 ft. Oil rose 1,200 ft. in the hole, however, no flows have been reported for the well. Little significance is seen in the discovery, it being practically surrounded by dry holes in the Swastika-sand level.

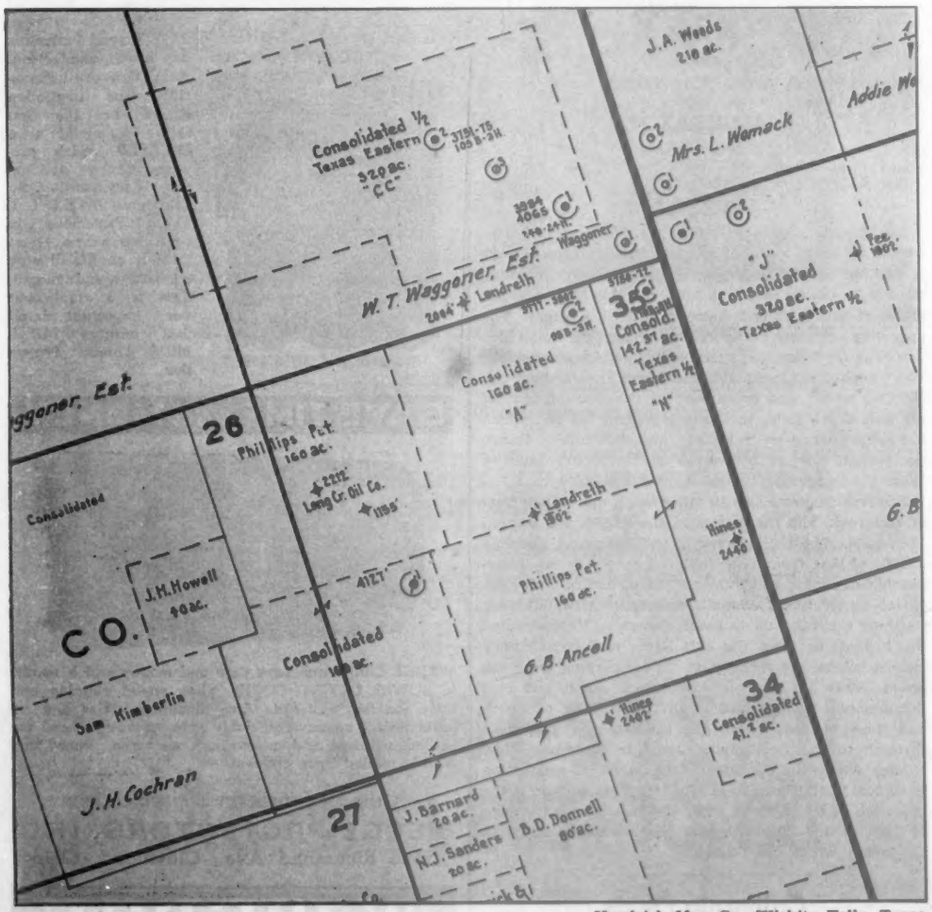
Possible ½-mile west extension for the north end of the Hull-Silk pool in Archer County was seen at an outpost drilled by L. T. Burns at his No. 1 Willmut, in the southeast corner of Lot 13, G. N. Smith Survey, Abstract 393. The test drilled oil sand from 4,376 to 4,384 ft. and cored sandy lime and oil sand from that depth to 4,396 ft., total depth. Operator was last reported running casing for completion. Location is west of the original Hull-Silk field.

Montague County centered considerable attention during the week as a wildcat test a mile north of the Bowers pool came in for a producer, possibly to extend production in that direction. United Producers Co. and Continental Oil Co.'s No. 1 West, in the L. S. Howard Survey, 1 mile southeast of the nearest production in the Bowers pool, encountered the third pay sand of the field at 3,914 ft. and drilled in sand to 3,930 ft. giving the well 16 ft. of pay section. The well showed for 10 bbl. of oil hourly, flowing, but went dead and operators prepared to install pumping unit. While attempting to hook up pump the well kicked off to flow 27 bbl. of oil in 1 hour and as the week closed testing continued.

Also in the Bowers pool, possibility of a mile northeast extension for the granite wash or middle pay zone of the field was seen at the Fisher & Thomas' No. 1 Reed, in the southwest corner of a 50-acre tract in the east end of the J. L. Graham Survey, Abstract 295. The wildcat drilled sand showing oil from 3,470 to 3,524 ft. and was drilling ahead below 3,802 ft. toward the deeper 3,900-ft. level in the field.

Extension of production on two sides of Montague County's Rogers & Rogers pool led development for that area. Spreading production in the townsite area a mile to the west was Stanolind Oil & Gas Co.'s outpost on the K. & R. Davis farm which picked up saturation in two zones from 4,322-40 ft. and from 4,363-72 ft. Testing was in progress as the week closed. South of production in the pool, Sunray Oil Co.'s No. 1 Burnett, offsetting a producer in the deepest pay, drilled oil sand from 4,630 to 4,653 ft., total depth. Casing was cemented on top of the sand and after plug was drilled the test showed only a little oil with drilling mud.

Beginning Magnolia Petroleum Co.'s development campaign on its recently acquired acreage in the Walnut Bend pool of northern Cooke County, the first test was started during the past week. It is the company's No. 1 Ramsey, east of production in the field and adjoining the Cox & Hamon lease. Considerable field development is being carried on in both the Walnut Bend field and the Voth and T.C.U. area in the central part of Cooke County.




Heydrick Map Co., Wichita Falls, Texas

*Wilbarger County's recently opened pool just across the line from Wichita County and the K.M.A. pool is rapidly becoming one of the more active areas in the district, new completions continue to broaden its undefined area*

## NORTH TEXAS COMPLETIONS

### Archer County

Blackwell Oil & Gas Co.'s No. 2 L. F. Wilson, 4,297-4,323 ft., 1,776 bbl. Chambers & Hanks' No. 2 D. R. Andrews, 927 ft., dry. Continental Oil Co.'s No. 4 L. F. Wilson McCrory 4,283-4,341 ft., 1,408 bbl. Helmerich & Payne and Blackwell's No. 7 L. F. Wilson, 4,340-56 ft., 1,320 bbl. Bert L. Ligon's No. 1 Dr. J. A. Little B, 4,303-27 ft., 610 bbl. Phillips Petroleum Co.'s No. 3 A. L. Moss, 4,296-4,334 ft., 1,383 bbl. Shappell Oil Co.'s No. 3 C. E. Carter, 935 ft., dry.

### Baylor County

British American Oil Producing Co.'s No. 3 F. C. Green C, 2,850 ft., dry.

### Clay County

Walter H. Gant's No. 1 Spring, 3,490-3,510 ft., 25 bbl. Harvey Drilling Co.'s No. 3 C. T. Raylor, 1,080 ft., dry. R. R. Kolp's No. 3 Magnolia, 324-34 ft., 7 bbl.

### Cooke County

Bridwell Oil Co.'s No. 1 Joe Fisher, 2,131 ft., dry. M. Staniforth, Jr.'s No. 2 Voth, 1,693-1,734 ft., 316 bbl. Texas Co.'s No. 5 F. J. Truebenbach A, 909-45 ft., 19 bbl.

### Jack County

Danciger Oil Refining, Inc.'s No. 2 T. E. Bailey A, 4,340-60 ft., 944 bbl.

### Montague County

United Producers Co.'s No. 1 J. T. West, 3,914-44 ft., 504 bbl.

### Wichita County

Bell Oil & Gas Co.'s No. 8 Evans B, 1,343-68 ft., 119 bbl. Bridwell Oil Co.'s No. 5 Mrs. Anna Mangold, 3,770-3,824 ft., 656 bbl. Bridwell Oil Co.'s No. 26 H. Willis, 1,087-1,115 ft., key well. Fain McGaha's No. 1 J. B. Tidwell, 3,786-3,830 ft., 2,480 bbl. J. E. Farrell's No. 6 J. L. and T. J. Waggoner H, 3,765-3,812 ft., 600 bbl. Felty & Harwell's No. 1 Mrs. Lilly Hooks, 3,880-4,035 ft., 336 bbl. Forbess & Golden's No. 10 C. A. Mertens, 556 ft., dry. Grace & Wood and others' No. 6 C. Birk, 3,891-4,060 ft., 1,112 bbl. Magnolia Petroleum Co.'s No. 157 H. Reilly, 1,325-37 ft., 45 bbl. Magnolia Petroleum Co.'s No. 158 H. Reilly, 1,441 ft., dry. George Proctor's No.

42 Ed Foster A, 580-610 ft., 10 bbl. Shell and Phillips' No. 7 R. L. Kempner, 3,775-3,875 ft., 536 bbl.

### Wilbarger County

Consolidated Oil Co.'s No. 1 G. B. Ancell J, 3,747-65 ft., 1,264 bbl. Lawson & Leavell's No. 1 Waggoner X, 1,945-52 ft., 45 bbl. Lido Oil Co.'s No. 22 Waggoner C, 2,753-60 ft., 392 bbl. Maxwell and others' No. 2 Zipperle, 968 ft., dry. T. B. Medders' No. 3 Waggoner, 2,279-2,316 ft., 125 bbl. Phillips Petroleum Co.'s No. 197 Waggoner, 3,056-70 ft., 406 bbl.

### Young County

Cable Oil Co.'s No. 45 L. A. Snider, 598 ft., dry. Cosden Oil Co.'s No. 2 D. R. Sewell B, 3,839-3,947 ft., 535 bbl. Holbrook & Wood's No. 6 S. E. Watson, 618 ft., dry.

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## EASTERN TEXAS

DALLAS, Tex., Nov. 13.—The Grapeland gas area of northern Houston County centered the attention in the eastern Texas district during the week as several new gas wells entered the completion stages and plans were started on two new recycling plants for the field.

Most recent of the completions are the two gas wells by the partnership of Lone Star Gas Co. and the Trinity Gas Co. The operators' No. 1 Denson, Breece Survey, was brought in last week for a gas well from saturation encountered from 6,018-32 ft. The operators' No. 1 Bean was brought in during the past week for a gasser from the pay drilled from 6,024-60 ft. and the No. 1 C. W. Smith is coring ahead below 6,014 ft. after topping the Woodbine at 6,010 ft. With the completion of these three gas wells plans were started for the operators' recycling plant which was announced for the area several months ago and was dependent upon the outcome of these three tests. Definite starting date or letting of construction contract has not been reported.

Another recycling plant for the field was in prospect by the Grapeland Oil Co. after completing its No. 1 Guice last week for 93,000,000 cu. ft. of gas daily.

Tentative plans for this plant, likewise, were announced several months past and were dependent upon the outcome of tests in the field.

Discovered in 1936, the field has seen relatively little development until the past few months. Until the completion of the four new gas wells in the past 2 weeks there were only three gas wells and one oil well in the entire field. Several other tests are at present active in the area. J. C. Cook's No. 1 B. T. Masters, Carpenter Survey, is cleaning into pits and making considerable gas and wash water from the Woodbine sand drilled from 6,017-28 ft. Cities Service Oil Co. has made location for its No. 1 Lively in the Heminger Survey of the field.

Eastern Texas' deep lower Marine-Trinity exploratory campaign yielded favorable results during the week as a new gas and distillate area was opened in Limestone County. Murray Samuell and S. J. Taylor's No. 1 C. Barron, south corner of the W. C. McKinzie Survey, 4 miles southwest of Groesbeck, was brought in to flow a large volume of gas and spray an unestimated amount of dark-colored distillate. At last reports the well was cleaning through ½-in. choke and showing pressures of 2,100 lb. on the tubing and 2,300 lb. on the casing. Flow is from casing perforations at 5,584-88 ft., 5,597-5,603 ft., and 5,605-11 ft. Operators reported that the well would be completed from these zones without testing the 4,600-ft. Glen Rose section, which showed some gas when drilled. Hole is bottomed at about 5,642 ft., plugged back from 6,051 ft., where gas and salt water were found in the Travis Peak formation.

Smith County's deep wildcat test, which has been attracting considerable attention in the eastern Texas area for several weeks, was abandoned at a total depth of 8,160 ft. It is the Texas Co.'s No. 1 A. A. Scritchfield, D. Page Survey, 2 miles northwest of Bullard.

Activity continued on the upturn in the Flag Lake-Bazette area of northwestern Henderson and extreme northern Navarro counties during the week as new wells and new locations were seen. Third producer for the Bazette Woodbine extension area of the Flag Lake field was assured in the Topaz Oil Co.'s No. 4 E. Trammel, A. C. Kyser Survey, south and west of the company's No. 2 Trammel. The well was reported to have drilled 14 ft. of Woodbine sand and estimates were as high as 400 bbl. daily for the new well. Across the Trinity River north and in Henderson County, the original Flag Lake field received renewed activity when Texas Co. made location for its No. 2 E. P. Harwell, Miller Survey. It is a south offset to the company's No. 1 E. P. Harwell (formerly Trinity farms). The test has been started and is drilling below 2,390 ft.

Another new test for the northwestern part of Henderson County is scheduled to get under way during the week. It is the Harry Hines and W. E. Howard's No. 1 Russom Mallory, Thomas Mitchell Survey, 2½ miles northeast of the Flag Lake pool and near the Mabank pool. Test was announced early in the fall, but drilling was held up for clearing of titles. Water line has been laid, derrick is up and machinery has been moved in, the contract calling for spudding by November 15.

## EAST TEXAS FIELD COMPLETIONS

(1-hour gages)

### Gregg County—Longview Area

W. L. Pickens' No. 6 E. Hoyt, 3,540-48 ft., 50 bbl. Stewart Oil Co.'s No. 2 Killingsworth, 3,578-96 ft., 5 bbl., pumping.

### Gregg County—Kilgore Area

Sinclair Prairie Oil Co.'s No. 66-A A. A. King, 3,459-3,585 ft., 45 bbl. Sinclair Prairie Oil Co.'s No. 62-B King trust, 3,471-3,532 ft., 60 bbl.

## EAST CENTRAL TEXAS COMPLETIONS

(24-hour gages)

### Anderson County

In the Cayuga field Carter-Gragg Oil Co.'s No. 2 W. H. C. Goode, Anderson County School Lands Survey, flowed 200 bbl. of oil in 4 hours from pay section from 3,980 to 4,010 ft. Carter-Gragg Oil Co.'s No. 1 C. W. McMahon, J. C. Collins Survey, flowed 85,000,000 cu. ft. of gas with 12 bbl. of dark distillate per million cubic feet of gas from pay section at 3,970-94 ft.

### Smith County

A wildcat, Texas Co.'s No. 1 A. Scritchfield, D. Page Survey, dry and abandoned at a total depth of 8,160 ft. after topping the Austin chalk at 4,722 ft., the Georgetown lime at 6,070 ft., the Fredericksburg at 7,265 ft., the Goodland at 7,405 ft., the Paluxy at 7,500 ft.


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# Texas and Louisiana Gulf

By
**NEIL WILLIAMS**

# East Bay, Galveston County, May Be Next Gulf Coast Pool

HOUSTON, Tex., Nov. 13.—A new field on the Texas Gulf Coast was indicated as Sun Oil Co. prepared to test No. 1-176 State, a marine operation in East Bay, Galveston County. While waiting for orders after running an electrical survey to 8,044 ft., the total depth, the master gate was shut in on the surface casing, and working pressure built up to 700 lb. The well was killed and casing is being cemented on bottom. The well is about 3 miles north of the Capien field, and approximately 1½ miles west of No. 179 State, a dry hole drilled several months ago. Details of the electrical survey were not available and it is not known where the sand section was topped.

Location for an interesting 7,000-ft. wildcat was made on Galveston Island, Galveston County, by Hebert & Smith, who are moving in material for No. 1 John Harris, center of Lots 341 and 346 in the Trimble & Lindsey subdivision, Section 3. The well is being drilled on a farmed-out lease from Gulf Oil Corp.

Approximately 1 mile northeast of the South China field, Jefferson County, Hebert & Smith are rigging up No. 1 John Guiterman, in Section 12, C. T. Taylor Survey. This well is on a farmed-out lease from Magnolia Petroleum Co. and will be drilled to a depth of 8,200 ft.

Titanic Oil Co.'s No. 1 S. E. Allen, a flank test on the Allen dome, Brazoria County, is drilling in shale below 5,300 ft., after a protection string of 7-in. casing was cemented through a heaving shale section topped at 4,830 ft. An electrical survey was run to bottom and it is reported that showings of oil and gas were indicated below 4,000 ft.

## Anchor Outposts

Two wells in the newly opened Anchor field had reached interesting depths. Humble Oil & Refining Co.'s No. 1 Mettler, J. De Valderas Survey, 1 mile northeast of the discovery well, topped Marginulina at 8,190 ft., and is drilling in sand below 9,023 ft. Glenn McCarthy's No. 1 Salmon & Momma, about 2,100 ft. northwest of the discovery, is drilling in shale below 9,016 ft. The Round Marginulina was topped at 7,896 ft., Flat Marginulina at 8,019 ft., and Marginulina No. 7 at 8,200 ft.

In the same county and located approximately 1½ miles northwest of the Chocolate Bayou discovery well, Glenn McCarthy's No. 1 Andrau, topped the Discorbis zone at 6,700 ft. and is drilling in shale below 7,049 ft.

On the east flank of the Fannett field, Jefferson County, Gulf Oil Corp.'s No. 12 Burrell, W. H. Smith Survey, is waiting for orders and may run casing for a production test after a 6-minute drill-stem test at 4,286-5,303 ft., the total depth, tested 30 lb. working pressure and 29 thribbles of oil and sand. This is the second sand section logged, as a sand at 3,614-35 ft. showed favorable indications on a drill-stem test.

In Chambers County and about 2½ miles northwest of the South Cotton Lake field, J. R. Turnbull's No. 1 Kirby Petroleum Co. flowed 79 bbl. per day through a ¼-in. choke under a tubing pressure of 150 lb. and casing pressure 1,100 lb. This well was tested the previous week in the Marginulina-Frio sand at 6,420-31 ft.

Another dry hole was marked up for the Addicks area, Harris County, with the abandonment of Temple Hargrove's No. 1 Herman Hospital at a total depth of 7,512 ft. The well is in the William Hardin Survey. North of Satsuma Dick Schwab and others spudded No. 1 Abe Gordeon in the M. Wood Survey, about 1 mile southeast of the operators' No. 1 Robertson, a dry hole abandoned the previous week.

In Liberty County and east of the Hankamer field, Hebert & Smith staked location for an 8,500-ft. wildcat on the E. W. Boyt farm in the H.&T.C. Survey No. 9. In the Hardin field, and east of production, O. W. Dyer's No. 2 Humphrey flowed 121 bbl. per day through a ⅛-in. choke. This well topped sand at 7,563 ft. and was completed at a plugged-back depth of 7,579 ft. It is the second completion in this area producing from a higher sand section than in the field proper.

## Louisiana Coast

Operators in coastal Louisiana were watching the results of a production test at Pan American Production Co.'s No. 1 Mills, a wildcat on La Place prospect, St. John the Baptist Parish. The hole is bottomed at 10,175 ft. with 7-in. casing cemented at 10,120 ft. The casing is expected to be perforated opposite an oil and gas sand topped at 10,000 ft., and if unsuccessful the hole will be plugged back, and a series of tests will be made in several gas and distillate sands logged between 8,200 and 9,000 ft., at which depth drill-stem testing showed favorable results.

In the Happytown area, St. Martin Parish, Shell Oil Co., Inc.'s No. 1 Iberville Land Co. is coring in shale below 9,861 ft. Two drill-stem tests in a sand section at 9,759-86 ft., showed an unestimated amount of 38-gravity oil and some salt water. Location is in Section 86-8s-7e.

One of the most interesting wells drilling in the district is Texas Co.'s No. 2 L. L. and E. Paradis in the Paradis field, St. Charles Parish. Two sand sections showing oil have been logged at 10,292-10,425 ft., and the well is coring below 10,770 ft. Sixty feet of sand was logged at 10,292-10,352 ft. while 40 ft. of sand was recovered at 10,360-10,400 ft. The discovery well of this field was completed in June as a distillate producer at 9,895-9,915 ft.

The Villa Platte field, Evangeline Parish, received its second Tertiary Wilcox producer as Continental Oil Co. completed No. 2 Corell for an initial production of 279 bbl. per day, flowing through a ¼-in. choke. The well was completed through perforated casing at 10,180-10,190 ft. J. K. Hughes' No. 1 Ortego, 2,000 ft. south of production, is reported to have been completed for a producer in the Wilcox section, but no production figures have been received. This well is 60 ft. higher than Continental Oil Co.'s No. 2 Corell, and cored sand showing oil at 10,080-60 ft.

Shell Oil Co., Inc.'s No. 4 Hanzen, ½ mile southwest of the Chalkley field, Cameron Parish, recovered 2,123 ft. of oil on a 12-minute drill-stem test at 8,838-50 ft., and casing is expected to be cemented for a production test at 8,890 ft., the total depth.

Sid Richardson's No. 1-A Haas Investment Co., 1½ miles southwest of the Eola field, was coring ahead for the Wilcox sand below 7,700 ft. A showing of oil and gas is reported to have been logged at 7,620-30 ft.

## Calcasieu Parish Prospect

Prospect of opening a new field in Calcasieu Parish was considered good by the showing of Gulf Oil Corp.'s No. 1 Amanda Brannon, Section 16-11s-10w. An electrical survey made at 9,023 ft. showed a sand section at 8,930-83 ft. with 150 mv. from 8,939-52 ft.; 4 ohms was recorded on the normal curve and 1 ohm on the third curve. Sidewall cores at 8,950 ft. showed sand with a faint odor, while at 8,940 ft. the section was logged as sand showing oil with a good odor and cut. Salt-water sand was cored at 9,156-62 ft. and the well is coring ahead.

California Co.'s No. 1 Adam Rutley, discovery well of the Barataria prospect, Jefferson Parish, flowed 272 bbl. daily through a ¼-in. choke with tubing pressure ranging from 1,360 to 1,400 lb. This well was completed the previous week through perforated casing at 8,204-14 ft. William Helis is reported to have farmed out his lease on Bayou Barataria to California Co. and drilling operations will be started in the near future. Rules and regulations regarding the development of the structure will be discussed at a hearing before the Department of Conservation November 23. Continental Oil Co.'s No. 1 Bernstein, 1 mile from the discovery well, is bottomed at 10,436 ft. and is scheduled to be abandoned.

In Assumption Parish, Falcon-Seaboard Drilling Co. is reported to have made locations for two wildcats on the old Napoleonville salt dome, and drilling is scheduled to be started on both locations immediately. Protection acreage is held by several major companies which are reported to have given bottom-hole money for the drilling of the two locations.

Location for an interesting wildcat was made by the Texas Co. for No. 1 State West Cote Blanche, about 2½ miles south of the Cote Blanche salt dome in Township 16s-7e.

## TEXAS GULF COAST COMPLETIONS IN PROVEN FIELDS

### Brazoria-Galveston Counties

Hastings field: Stanolind Oil & Gas Co.'s No. 35 Curkett, 6,090 ft., 521 bbl., ¼-in. choke. Stanolind Oil & Gas Co.'s No. 4 Reichardt, perforated casing 5,753-75 ft., 861 bbl., ¼-in. choke. Stanolind Oil & Gas Co.'s No. 12 Edwards, sand 6,085-96 ft., 423 bbl., ¼-in. choke. Stanolind Oil & Gas Co.'s No. 7 McDonald, sand 6,095-6,105 ft., 445 bbl., ¼-in. choke.

### Chambers County

Anahuac field: Humble Oil & Refining Co.'s No. 23 Clark, 7,113 ft., 552 bbl., ¼-in. choke. Cedar Point field: Standard Oil Co. of Texas' No. 24-118 State, perforated casing 5,945-80 ft., 220 bbl., ⅛-in. choke.

### Fort Bend County

Thompson field: J. H. Blaffer's No. 4 Davis, sand 5,389-5,406 ft., 592 bbl., ¼-in. choke. Humble Oil & Refining Co.'s No. 17 Davis, sand 5,399-5,410 ft., 238 bbl., ¼-in. choke.

### Harris County

Bammel field: H. M. Harrell's No. 1 Thornton, perforated casing 6,178-82 ft., gas well. Clear Lake field: Clear Lake field Humble Oil & Refining Co.'s No. 24-C Humble-West, 5,860 ft., gas well. Friendswood field: Humble Oil & Refining Co.'s No. 18 Kiesling-Dixon, sand 5,868-6,046 ft., 532 bbl., ¼-in. choke. Pierce Junction field: Gulf Oil Corp.'s No. 14 H. C. Cain, sand 4,581-95 ft., 239 bbl., ¼-in. choke. Tomball field: Humble Oil & Refining Co.'s No. 1 Theis, sand 5,615-22 ft., 416 bbl., ¼-in. choke.

### Jackson County

Cordele field: Humble Oil & Refining Co.'s No. 4 Kubecka, 2,706 ft., 142 bbl., ¼-in. choke. Texana field: Moore & Ahern's No. 1 C. C. Clement, 6,258 ft., dry and abandoned.

### Jefferson County

Lovells Lake field: Humble Oil & Refining Co.'s No. 2-B Steinhagen sand 7,777-85 ft., 165 bbl., ¼-in. choke. Stanolind Oil & Gas Co.'s No. 1-B Steinhagen, perforated casing 7,775-80 ft., 170 bbl., ⅛-in. choke. Spindletop field: Unity Oil Co.'s No. 46 fee, sand 888-90 ft., 132 bbl., pumping. Amelia field: Stanolind Oil & Gas Co.'s No. 10 McCormick, 5,390 ft., 209 bbl., ¼-in. choke.

### Liberty County

Hardin field: O. W. Dyer's No. 2 Humphrey, sand 7,563-79 ft., 121 bbl., ⅛-in. choke.

### Tyler County

Spurger field: Republic Production Co.'s No. 26 fee,

perforated casing 7,682-7,702 ft., 425 bbl., ¼-in. choke. Republic Production Co.'s No. 27 fee, perforated casing 7,685-7,706 ft., 525 bbl., ¼-in. choke.

### Polk County

Segno field: Gulf Oil Corp.'s No. 23 Wing, sand 8,114-21 ft., 432 bbl., ¼-in. choke.

### Wharton County

Louise field: Gulf Stream, Inc.'s No. 4 Adams, 5,140 ft., 35 bbl., pumping. Magnet field: Humble Oil & Refining Co.'s No. 21 Cockburn sand 5,530-40 ft., 141 bbl., ¼-in. choke. Withers field: McDannald Oil Co.'s No. 1 Garston-Broussard, sand 5,544 ft., 120 bbl., ⅛-in. choke.

## West Texas Fields

*(Continued from Page 227)*

### Callahan County

Hart's No. 1 Yost, dry and abandoned at 656 ft. Reeve's No. 1 Hatchett, dry and abandoned at total depth of 500 ft. O. Wagley's No. 1 fee, dry and abandoned at total depth of 282 ft. C. A. Warren's No. 1-B Clinton, 1,661-71 ft., 30 bbl. daily.

### Hood County

Sowell's No. 1 Burton, dry and abandoned at 4,379 ft.

### Jones County

Humble Oil & Refining Co.'s No. 17 Hollums, 3,238-45 ft., 474 bbl. in 11 hours. Moutray & King's No. 1 Rutledge, 1,933-37 ft., 76 bbl. daily.

### Shackelford County

Blanton's No. 1 fee, dry and abandoned at total depth of 550 ft. Evans' No. 1 Lee, dry and abandoned at total depth of 1,297 ft. Hoffman & Page's No. 38 Morris, 1,638-45 ft., 8 bbl. daily. Owens-Snebold Oil Corp.'s No. 3 McCown, 3,148-81 ft., 448 bbl. daily. Valley Osage Oil Co.'s No. 3 McKeever, 3,175-95 ft., 443 bbl. in 11 hours.

### Stephens County

Swanson's No. 1 Veale-Frost, dry and abandoned at total depth of 4,373 ft. after topping dry Ellenburger lime at 4,333 ft. and encountering salt water at 4,370 ft.

### PANHANDLE FIELD COMPLETIONS

(24-hour gages)

### Carson County

Magnolia Petroleum Co.'s No. 63 fee (244), 2,985-3,050 ft., 197 bbl.

### Gray County

Humble Oil & Refining Co.'s No. 10 Merton, 3,171-3,258 ft., 355 bbl. Magnolia Petroleum Co.'s No. 9 Barrett, 3,230-75 ft., pumped 132 bbl. Shell Oil Co., Inc.'s No. 4 McConnell, 3,118-88 ft., pumped 173 bbl. Texas Co.'s No. 31 Saunders, 2,850-95 ft., 504 bbl. Tripplehorn's No. 4 Webb, 2,520-95 ft., 428 bbl.

### Hutchinson County

Travelers Oil Co.'s No. 8 Haile B, 2,979-3,035 ft., 755 bbl.

### Moore County

Panhandle Eastern Pipe Line Co.'s No. 1-3 Sneed, 2,485-2,595 ft., 25,900,000 cu. ft. Panhandle Eastern Pipe Line Co.'s No. 1-63 Brown, 2,610-3,155 ft., 22,100,000 cu. ft. Panhandle Eastern Pipe Line Co.'s No. 1-20 Sneed, 2,735-3,135 ft., 27,800,000 cu. ft. Panhandle Eastern Pipe Line Co.'s No. 1-50 Sneed, 2,445-2,660 ft., 93,434,000 cu. ft. Panhandle Eastern Pipe Line Co.'s No. 1-34 Brown, 2,610-2,785 ft., 46,510,000 cu. ft.

### Wheeler County

Elbar Oil Co.'s No. 13 Noel, 2,385-2,445 ft., 244 bbl.

## Ohio Fields

*(Continued from Page 223)*

wood Township, Purdy Co.'s No. 1 M. E. Morgan, Section 15, had 150,000 cu. ft. of gas at 965 ft. Washington Township, Jewell Gas Co.'s No. 1 Ray Wayble. Section 18, showed 80,000 cu. ft. of gas in Berea at 1,230 ft., but was abandoned at 1,287 ft.

In Hocking County, Green Township, ½ mile east of Logan, Kackelmacker estate's No. 1 John Dougherty. Section 34, made 5 bbl. of oil and some gas from Clinton the first day after the shot, total depth 2,682 ft. In the same township in Section 30, Joe Reuben and others' No. 1 Noah Wood found the Clinton dry, total depth 3,033 ft.

Knox County, Howard Township, H. E. Perkins' No. 2 Isabelle Robinson, Lot 5, was dry in Clinton, total depth 2,620 ft.

Lake County, Concord Township, Cushing & Dempsey's No. 1 S. J. Monch, Section 12, found the Clinton dry, sand at 3,103-75 ft., total depth 3,246 ft.

In Licking County, three gas wells and four dry holes were completed in Clinton sand in the Newark field. In Mary Ann Township Moore & Murphy's No. 1 Sarah Swisher, Section 25, was shut in after a shot brought a production of 250,000 cu. ft. from sand at 2,577-2,612 ft. Alber Wiley and others' No. 2 T. B. Hirst, Section 25, gaged 1,200,000 cu. ft., open flow, from sand at 2,594-2,624 ft. Guy Shrider and others' No. 1 William Stricker, Section 17, was dry at 2,623 ft. Ohio Fuel Gas Co.'s No. 1 Della Pound, Section 24, was drilled through the Clinton at 2,619 ft. but was dry. Hoover Brothers' No. 1 Katherine Stewart, Section 5, dry in Clinton at 2,636 ft., had an oil and gas showing in the Newburg at 2,203-15 ft. It was shot and made 16 bbl. of oil and 100,000 cu. ft. of gas the first 24 hours, but water drowned out the production and the well was abandoned. Madison Township, Bebout & Sons' No. 2 Regina Wahl, Lot 5, was shut in with a 300,000 cu. ft. production after a shot in sand at 2,605-27 ft. Newark Township, Hazlett and others' No. 1 Mary Glaub, first quarter, was dry, total depth 2,716 ft.

Medina County, Chatham Township, Preston Oil Co.'s No. 7, Lot 6, Tract 16, made 6 bbl. of oil from Berea in 24 hours after the shot in sand at 293-309 ft. Spencer Township, Glen Harmon's No. 1 Roy E. Stroup, Section 7, gaged 475,000 cu. ft. from Clinton sand at 2,639 ft. In Section 10, East Ohio Gas Co.'s No. 1 De Forest Jackson was dry in the Clinton at a total depth of 2,595 ft.

Meigs County, Salisbury Township, Bengie &

*(Continued on Page 244)*

*Marsh pressure gauges on centrifugal circulating pumps and natural gasoline plant.*

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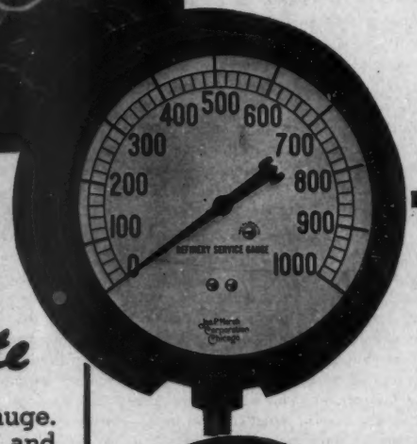


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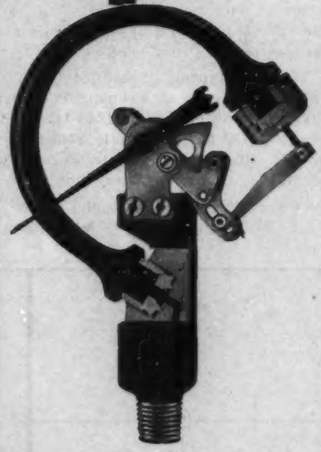

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# Kansas Developments

By
DAL DALRYMPLE

# Wildcats in Barton and Rice Counties Find New Oil Areas

Barton County accounted for two discoveries in Kansas the past week, one wildcat finding Arbuckle-lime production and another outpost opening a quartzite or Gorham-sand area. Other wildcat development included completion of pool openers or extension wells in Rice, Stafford and Johnson counties and abandonment of a Butler County test that previously had been considered a discovery. Several new wildcats were started and operations generally throughout the state appeared to be interesting.

R. E. Day and others' No. 1 Feltes, SE SE NE Section 14-16-12w, wildcat 1 mile west of the West Prusa pool and 1½ miles east of the Beaver pool, northeastern Barton County, was the Arbuckle-lime discovery. It found pay in the lime at 3,342-44 ft., total depth, and 2,800 ft. of oil rose in the hole in 12 hours. At the end of 20 hours oil was standing 3,150 ft. in the hole. Gravity of the oil was 42° at 63°. Tanks were to be erected preparatory to testing.

In the adjoining township G. F. Johnson, B.B.&M. Drilling Co. and others' No. 1 Krier, CEL SE SE Section 30-16-11w, found oil in quartzite or Gorham sand at 3,325-27 ft., total depth. It swabbed 22½ bbl. of oil an hour for 2 hours and later was reported to have swabbed 30 bbl. an hour for 4 hours and made preliminary potential of 360 bbl. of oil daily. It was expected potential would be increased when permanent potential is determined. The wildcat previously had found oil in Lansing lime at 3,055 ft., and in Topeka lime topped at 2,690 ft., but the shallow showings were passed up. Location is about 1¼ miles southwest of nearest production in the Prusa pool.

The Zenith pool in Stafford County was extended ¼ mile eastward at Magnolia Petroleum Co.'s No. 1 Trebar, SW SE SE Section 12-24-11w. It topped Misener sand at 3,732 ft., total depth 3,744 ft., and swabbed 15 bbl. of oil an hour. It extends production to within ¼ mile of the Reno County line.

Fred Jones, I. W. Murfin and others' No. 1 Behnke, CW½ SW NW Section 25-18-10w, was completed to open a quartzite pool 1 mile east of the Orth area in Rice County. It found quartzite pay at 3,204-09 ft., total depth, pumped 268 bbl. of oil in 8 hours and made daily potential of 805 bbl. Gravity of the oil was 43.8°. Topeka lime was topped at 2,450 ft., and a showing of oil was found at 2,670-75 ft. Lansing lime was topped at 2,863 ft. and at 2,940-44 ft. it gaged 2,106,000 cu. ft. of gas. The gas increased to 3,168,000 cu. ft. at 2,950 ft. Gas was killed and as the hole was deepened showings of oil were found at 3,048-49 ft.

Phoenix Drilling Co.'s No. 1 Linville, SW SW SE Section 4-20-10w, opened a new area about ¾ mile southeast of nearest production in the Silica field, Rice County. Arbuckle lime was found at 3,388 ft., and it was bottomed at 3,396 ft. It was acidized with 1,000 gal. and swabbed 40 bbl. of oil in 12 hours, with 50 per cent water. It was reacidized with 2,000 gal. and completed for 15 bbl. of oil daily.

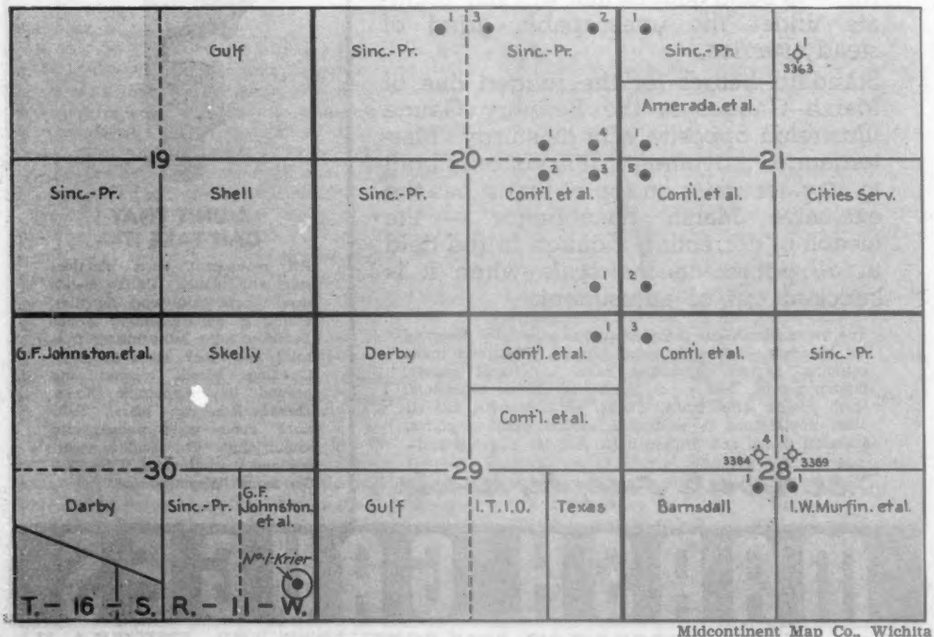
Crown Petroleum Co., Ash & Hershey's No. 1 Schartz, SE SE NW Section 12-20-12w, about ¾ mile west of production in the West Ellinwood pool, Barton County, a September discovery, was completed in Arbuckle lime at 3,343-63 ft., total depth. After acid treatment it pumped 42 bbl. of 37.5-gravity oil in 8 hours and made daily potential of 126 bbl.

OK Supply Co. and others' No. 1 Gardner, SE SE NE Section 4-14-22e, north of the Gardner pool in Johnson County, found Squirrel sand at 615-21 ft., had dry Bartlesville sand at 785-92 ft., and was plugged back to 621 ft. After 2-in. tubing was run, it gaged 180,000 cu. ft. of gas daily and was completed.

Seaney & Clampitt and others' No. 1 Schauf, CSL E½ SW Section 1-16-12w, Barton County wildcat, topped Arbuckle lime at 3,358 ft., and was dry and abandoned at 3,393 ft., total depth.

Marylyn Oil Co. and others' No. 1-A Hoard ranch, SW NE NE Section 28-29-8, southeastern Butler County, had showings of oil in Lansing-Kansas City lime series topped at 1,625 ft., and operators were preparing to test a good showing of oil in the first break in Mississippi lime topped at 2,836 ft., total depth 2,889 ft., when rig burned and it was abandoned.

Ridell & Davidson and others' No. 1 Boals, C NW Section 15-21-12, wildcat location in Lyon County, was abandoned.




Midcontinent Map Co., Wichita

*George F. Johnson, C. R. Pigott and B. B. & M. Oil Co.'s No. 1 Krier, Section 30-16-11w, Barton County, opened a producing area 1½ miles southwest of the Prusa pool*

Ridell & Davidson and others' No. 1 Boals, C NW Section 15-21-12, wildcat location in Lyon County, was abandoned.

## New Wildcat Tests

Cities Service Oil Co.'s No. 1 well, SW SW NE Section 10-9-27w, is a wildcat location 7 miles southeast of the town of Hoxie, Sheridan County. This is the first wildcat to be started in the county in about 2 years. Location is on a block spreading over an area 6 miles long and 5 miles wide. The Continental, Gulf, and Skelly companies hold checkerboard leases in the area. Nearest production is in the Wakeeney pool, Trego County, about 29 miles southeastward.

Four new outposts were reported in Cowley County. Ben Gralapp's No. 1 Ireton, C E½ SE NE Section 7-31-4, northwest of the Hittle pool and ¾ mile from the Clark pool, was moving in material. Mission Oil Co. and others' No. 1-A Hunt, SW SW NE Section 16-34-5, about 9 miles southwest of the Wilson pool, was moving in material. Mitchell Drilling Co. and others' No. 1 Batchelder, SW SW SW Section 27-30-6, about 2 miles northeast of the Eastman pool, also was moving in material. Markey & Talbott and others' No. 1 Anderson, C N½ NE NW Section 21-30-3, about 1 mile north of the Udall pool, was a cellar.

Patton Drilling Co.'s No. 1 Hoss, C W½ NW SW Section 12-30-15w, some 12 miles northwest of the Lake City pool in Barber County, was a location. It is on a Skelly Oil Co. farmout in an area previously untested.

Sunray Oil Co.'s No. 1 Anderson, C W½ SW NW Section 17-20-5w, is location for a McPherson County wildcat, 2 miles north of the Bornholdt pool. Fain Drilling Co.'s No. 1 Briggs, C W½ SW SW Section 21-20-5w, about 1¼ miles northeast of the Bornholdt pool, was a cellar. Henry Bennett and associates were reported to have made location for No. 1 Petz, SW SW NW Section 8-21-5w, a wildcat 2 miles south of the Bornholdt pool.

Shell Oil Co., Inc., started work at No. 1 Bender, SW SW SE Section 20-15-14w, wildcat in Russell County, 3 miles west of the Trapp field.

G. M. Pigott and others' No. 1 Schneider, C N½ NW NW Section 6-18-15w, was location for a wildcat 2 miles from production in the Otis field and only 660 ft. east of the Rush County line, in Barton County.

Paul W. Fleegar, Hugh McClellan and W. E. McPherson's No. 1 Brown, SW SW SE Section 1-21-13w, Stafford County, was a location 4 miles northeast of the Gates pool. Derby Oil Co.'s No. 1 Williams, C NW NE Section 14-20-8w, 1 mile south of the Lyons gas area, Rice County, had started work.

Wells completed and new operations reported the past week include the following:

## Russell County

Coralena Oil Co.'s No. 15 Deines, NW SW NE Section 36-15-14w, Trapp field, total depth 3,300 ft. in Arbuckle lime, acidized, made, initial daily potential of 2,014 bbl. of oil. Wolf Creek Oil Co.'s No. 4-B Roubach, C N½ SE NW Section 15-14-15w, Sullivan-Gorham area, was bottomed at 3,234 ft. in Gorham sand and made potential of 2,864 bbl. daily. Coralena Oil Co.'s No. 2 Cora Trapp, C W½ E½ NE Section 29-15-13w, Trapp field, was completed for 100 bbl. of oil daily at 3,331 ft., total depth, in Arbuckle lime. W. I. Southern, Inc.'s No. 7 Neidens, NW NE NE Section 32-15-13w, made depthograph potential of 1,045 bbl. of oil daily at 3,330 ft., total depth, in Arbuckle lime.

Phillips Petroleum Co.'s No. 1 Mai, NE NE SW Section 15-15-14w, West Trapp area, was bottomed at 3,324 ft. in Arbuckle lime, acidized and made echometer potential of 340 bbl. of oil daily. Cities Service Oil Co.'s

No. 2 Cook, SW NW SE Section 4-15-12w, Greenvale pool, drilled to 3,020 ft. in Lansing lime, acidized and made initial potential of 823 bbl. of oil daily. Stanolind Oil & Gas Co.'s No. 6-A Krug, SE SE NE Section 27-14-14w, Gurney pool, was acidized and made daily potential of 412 bbl. of oil from Lansing lime at 2,994 ft., total depth.

Cities Service Oil Co.'s No. 3 Carter, CSL SW NE Section 29-14-13w, Hall pool, stopped at total depth of 2,993 ft. in Lansing lime, was acidized and made initial daily potential of 864 bbl. of oil. Coralena Oil Co.'s No. 6 Sellens, Section 29-15-13w, Trapp field, was bottomed at 3,334 ft. in Arbuckle lime, acidized and made initial daily potential of 1,270 bbl. of oil. A. H. Witt's No. 1-B Witt, SE SW SW Section 10-14-15w, Gorham pool, was acidized and made potential of 169 bbl. of oil in 24 hours from Gorham sand at 3,240 ft., total depth.

New work in Russell County: Skelly Oil Co.'s No. 6 Rein, C S½ NE SE Section 8-15-13w, Coralena pool, moving in material; W. I. Southern, Inc.'s No. 2 Letsch, SE SE SW Section 17-15-13w, moving in material; Coralena Oil Co.'s No. 4 Dumler, C E½ E½ NW Section 36-15-14w, Trapp field, rotary rig.

## Estimated Daily Production

Estimated daily production for Kansas for the week ended November 11, and for the preceding week was as follows:

| | Barrels | |
|---|---|---|
| | Nov. 11 | Nov. 4 |
| Oxford City | 775 | 775 |
| Burrton | 10,875 | 10,425 |
| Ritz-Canton | 4,375 | 4,250 |
| Graber | 2,175 | 2,775 |
| Hollow-Nikkel | 2,300 | 2,075 |
| Lerado | 625 | 1,075 |
| Voshell | 1,625 | 2,575 |
| Wellington | 2,175 | 2,150 |
| Ellsworth County: | | |
| Lorraine | 1,600 | 1,600 |
| Other pools | 1,220 | 1,515 |
| Rice-Barton counties: | | |
| Bloomer | 2,400 | 2,950 |
| Chase | 4,525 | 4,075 |
| Geneseo | 4,000 | 3,550 |
| Raymond | 900 | 325 |
| Silica | 9,950 | 13,575 |
| South Silica | 2,150 | 1,850 |
| Keesling | 675 | 975 |
| Wherry | 3,650 | 3,150 |
| Miscellaneous Rice | 4,450 | 4,985 |
| Miscellaneous Barton | 7,105 | 7,575 |
| Russell County | 24,175 | 25,500 |
| Sedgwick County | 3,300 | 3,250 |
| Ellis County: | | |
| Bemis | 7,225 | 7,350 |
| Miscellaneous | 4,100 | 4,460 |
| Kingman County | 650 | 670 |
| Stafford County | 8,340 | 8,730 |
| Greenwood County | 9,100 | 9,100 |
| El Dorado | 7,575 | 7,600 |
| Other fields | 33,885 | 35,365 |
| Total Kansas | 164,900 | 173,250 |

## Rice County

Cities Service Co.'s No. 1 Hathaway, C N½ NE SW Section 27-19-10w, Silica field, Rice County, total depth 3,253 ft. in Arbuckle lime, made daily potential of 261 bbl. of oil. L. E. Douglass Oil & Gas Co.'s No. 6 Hauschild, C S½ SE NW Section 15-21-7w, Wherry pool, was bottomed at 3,406 ft. in conglomerate and made 24-hour potential of 899 bbl. of oil. Continental Oil Co.'s No. 3 Poland, NW NW SE Section 30-18-7w, Geneseo field, total depth 3,189 ft. in Arbuckle lime, made initial potential of 170 bbl. of oil daily. Same company's No. 8 Nickel, NW SE SW Section 13-18-8w, total depth 3,222 ft. in Arbuckle lime, was acidized and made depthograph potential of 3,000 bbl. of oil daily.

S. J. Polhamus and others' No. 1 Gum, C E½ NE SE Section 34-19-10w, ½ mile from production in the northeast extension of the Silica pool, was a cellar.

## Ellsworth County

Continental Oil Co.'s No. 8 Rolfs, CWL W½ NW Section 34-17-8w, Edwards pool, Ellsworth County, was bottomed at 3,228 ft., acidized and made depthograph potential of 3,000 bbl. of oil daily.

## McPherson County

Continental Oil Co.'s No. 1 Peterson, NW SW NW Section 32-20-5w, Bornholdt pool, McPherson County, was bottomed in chat at 3,384 ft. and made initial 24-hour potential of 1,487 bbl. of oil. E. K. Carey and Phillips Petroleum Co.'s No. 1 Ely, C N½ NW NW Section 6-21-5w, outpost ¾ mile south of Bornholdt pool, was dry and abandoned at 3,375 ft., total depth, in chat. Hammer & McLean Drilling Co.'s No. 5 Sellers, CNL NE¼ Section 31-19-1w, Ritz-Canton field, produced 137 bbl. of oil daily at total depth of 2,978 ft. in chat.

## Stafford County

Stanolind Oil & Gas Co.'s No. 7 Fuller, C S½ SW SW Section 11-24-11w, Zenith field, Stafford County, total depth 3,782 ft. in Misener sand, made initial daily potential of 802 bbl. of oil by bottom-hole pressure method.

Same company's No. 2 Hitz, C W½ SE NW Section 2-22-12w, South Sittner pool, was a rig. Continental Oil Co.'s No. 1 Keller, NE NE NE Section 22-24-13w, St. John, was a cellar.

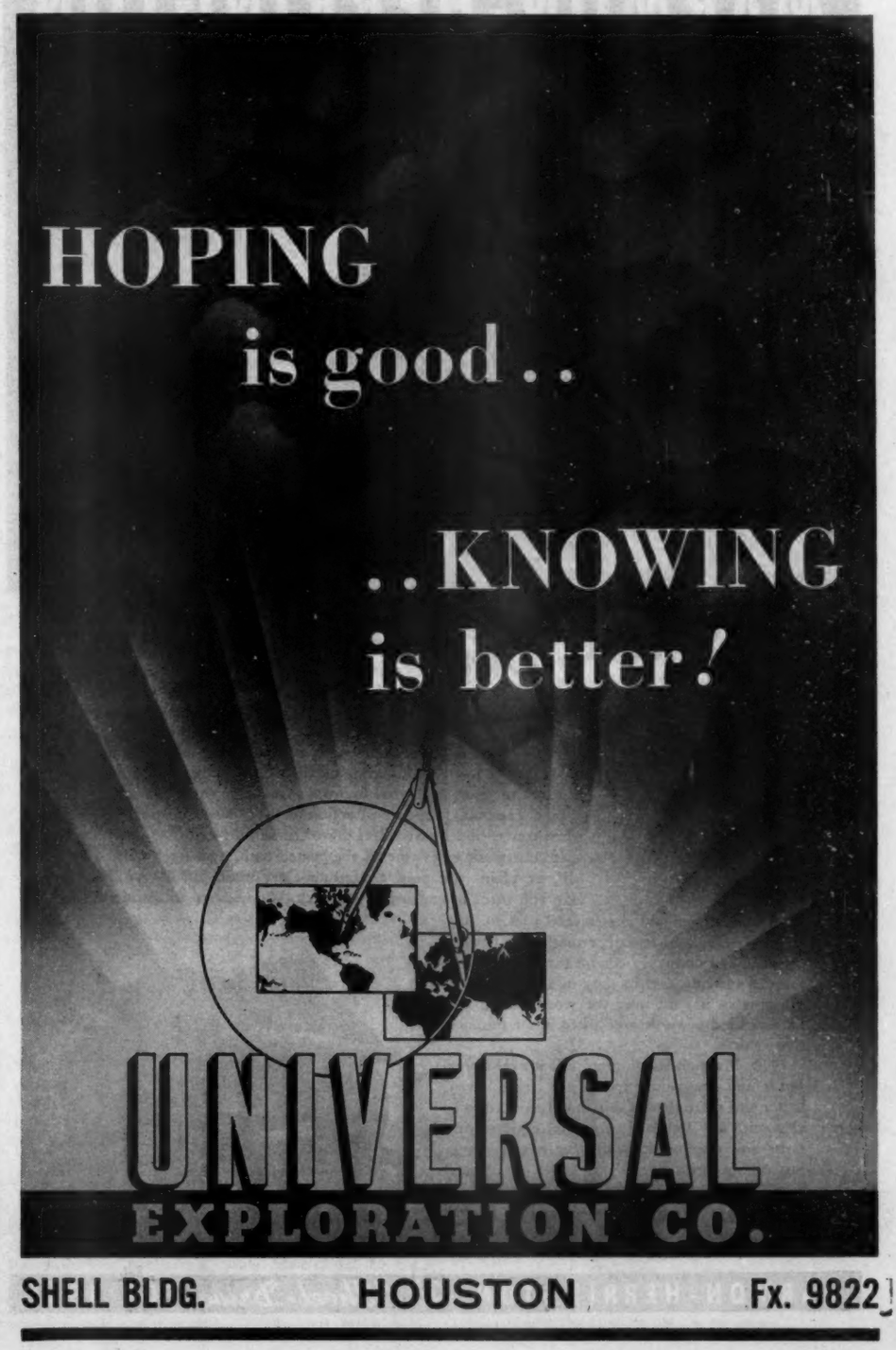
## Ellis County

Wilton C. Emrich and others' No. 1 Joy, C S½ SE Section 14-12-18w, Koblitz area, Ellis County, was dry and abandoned at total depth of 3,755 ft. in Arbuckle lime. J. J. Hall's No. 1 Oswald, SW SW SE Section 11-12-16w, Blue Hill pool, total depth 3,100 ft. in Lansing lime, made potential of 135 bbl. of oil daily. Shell Oil Co.'s No. 27 Rumsey, SE NE NE Section 23-11-17w, Bemis field, made 24-hour potential of 189 bbl. of oil at total depth of 3,432 ft. in Arbuckle lime. Cities Service Oil Co.'s No. 4 Callahan, NW SW NW Section 24-11-17w, was acidized and made echometer potential of 3,500 bbl. of oil daily at total depth of 3,420 ft. in Arbuckle lime. Darby Petroleum Corp.'s No. 2-A Peavey, Section 13-11-18w, South Burnett pool, was bottomed at 3,434 ft. in Arbuckle lime, was acidized and completed for initial potential of 3,500 bbl. of oil daily, top limitation on depthograph potential.

Cities Service Oil Co.'s No. 5 Callahan, SW NW NW Section 24-11-17w, set casing and was waiting on cement at 1,015 ft.; Frank Hollow and others' No. 1 Thomas, S½ SE SE Section 3-12-18w, Walter area, was building rotary rig.

## Barton County

Transwestern Oil Co.'s No. 1-A Pospishel, CWL NW SW Section 21-17-15w, Pospishel pool, Barton County, was acidized and made daily potential of 292 bbl. of oil at 3,590 ft., total depth, in Arbuckle lime. Stanolind Oil & Gas Co.'s No. 17 Panning, SW SE SE Section 10-20-11w, Silica field, was bottomed at 3,288 ft. in Arbuckle lime, acidized and made depthograph potential of 1,789 bbl. of oil daily. Same company's No. 11 Stueckemann, C S½ SE Section 11-20-11w, was acidized and made depthograph potential of 1,551 bbl. of oil daily at total depth of 3,287 ft. Sinclair Prairie Oil Co.'s No. 5 Seyfert, NW NW SW Section 21-16-11w, Prusa pool, stopped at 3,327

ft. in Arbuckle lime and made initial daily potential of 2,654 bbl. of oil.

New operations in Barton County: Stanolind Oil & Gas Co.'s No. 4 Jutting, C E½ NE NE Section 15-20-11w, Ellinwood area, drilling below 1,642 ft.; Magnolia Petroleum Co.'s No. 18 Roetzel, C E½ NE SE Section 24-20-11w, South Silica area, building rotary rig; Sinclair Prairie Oil Co.'s No. 1 Edwards, NE NE SE Section 18-16-11w, West Prusa area, building rig; Shell Oil Co.'s No. 2 Radenberg, SW NW NW Section 3-17-11w, Kraft pool, moving in material.

### Cowley County

McKnab & Blair's No. 3 Hittle, NW NW NE Section 21-31-4, Hittle pool, was drilling below 2,255 ft. Allred & Glass' No. 1 Miller, C SW SW Section 26-32-5, Frog Hollow area, was drilling below 388 ft.

Harbar Drilling Co.'s No. 9 Waite, SW SW NW Section 21-31-4, Hittle pool, Cowley County, made 24-hour potential of 633 bbl. of oil at total depth of 3,353 ft. in Arbuckle lime. Ben Gralapp's No. 1 Ellinger, C NE NE Section 27-32-5, gaged 500,000 cu. ft. of gas daily at total depth of 660 ft. Same operator's No. 1 Ellinger, C NW NE Section 27-32-5, gaged 500,000 cu. ft. of gas daily at 650 ft., total depth.

### Greenwood-Woodson Counties

O. K. Oil Co.'s No. 12 Shedell, SW SW NW Section 15-23-13, Greenwood County, was acidized and produced 10 bbl. of oil daily from Mississippi lime at 1,771 ft.

In Butler County Rex & Morris and others' No. 4 Johnson, SE NE SE Section 20-26-7, was moving in material.

In Marion County Harwood Oil Co.'s No. 5 Novak, NW NE SW Section 28-17-4, Lost Springs area, was rigging up.

In Harvey County E. J. Shaffer and others' No. 2 Wilson, C N½ NW NW Section 20-23-3w, Burrton area, was building rotary rig.

C. B. Alexander and others' No. 4 Haas, NE SE SE Section 22-23-14, Woodson County, was dry and abandoned at 1,690 ft., total depth. Keene & Henderson's No. 1 Pipe, SE NW SE Section 19-23-15, Woodson County, was dry and abandoned at total depth of 1,550 ft.

### Barber County

Barbara Oil & Gas Co.'s No. 2-B Thompson, C NE¼ Section 16-33-13w, Medicine Lodge field, was bottomed at 4,958 ft., perforated casing at 4,603-4,660 ft. and gaged 16,500,000 cu. ft. of gas daily.

### Kingman County

Skelly Oil Co.'s No. 3 Conley, CSL N½ SW Section 20-27-10w, Cunningham field, Kingman County, total depth 3,430 ft., acidized and made 24-hour potential of 201 bbl. of oil daily.

Same operator's No. 5 Maxedon, SE NW SE Section 25-27-11w, Pratt County sector of the Cunningham field, was building rotary rig.

## Forest City Basin Activity

ST. JOSEPH, Mo., Nov. 13—Phillips Petroleum Co. is moving cable tool equipment into Union County, Iowa, for the first test to be started by a major company in that sector of the Forest City Basin. Over in southeastern Nebraska the Pawnee Royalty Co., the Odessa, Texas, firm that drilled the first producing oil well in Nebraska, was preparing to start a second test. In the Missouri part of the basin, a Wilcox sand failure was recorded, one wildcat found gas production and work was resumed at a wildcat just east of St. Joseph. A small gas well was completed to open a new area in Johnson County, Kansas, on the south flank of the basin.

The new Iowa test is due to spud Nov. 28, the birthday anniversary of Frank Phillips, chairman of the board of the operating company. It is the No. 1 Creston, C SE NE Section 31-71-30w, about 10 miles south of the town of Creston, Union County. Structure was determined through shooting and coring.

Work was resumed at Bob Miller and others' No. 1 Corrough, C SE SE Section 24-57-35w, east of St. Joseph in Buchanan County, Mo., after new equipment was moved in. It was spudded more than a month ago. It is shut down at 203 ft., waiting for casing. Surface pipe was run to 142 ft. A group of St. Joseph business men have an interest in the well and block.

G. A. Vincent and others were building road and moving in material at No. 1 Dillingham, C NE SW Section 16-53-34w, northeast of Platte City, in Platte County. Davis Brothers have the contract to drill to 100 ft. in Arbuckle lime. Location is on a farmout block from Indian Territory Illuminating Oil Co., which worked the area with seismograph before completing the block last year. Mr. Vincent has sold a spread of leases to the Missouri Valley Gas & Oil Co. and to Minneapolis interests.

E. F. Neely's No. 1 Shores, SE SE SE Section 12-60-37w, wildcat in Andrew County, is believed nearing a decision, although operators are withholding information. It unofficially was reported drilling at about 2,400 ft. in hard Viola lime.

Ward McGinnis' No. 1 Laughlin, SE SE SW Section 18-62-15w, Adair County, was drilling below 1,100 ft. Morrow & Rodgers and others were drilling out plug at No. 1 Cooley, NW SE SE NW Section 33-64-17w, Adair County, and is due to drill ahead to Arbuckle lime. It was plugged back from 965 ft. to test a showing of oil in Hunton lime at 871-886 ft., but results were unsatisfactory.

Same operators were reported rigging up at No. 1 Seamster, Section 6-65-13w, Schuyler County. Huntsman & Peters of Barnesville, Ohio, have the contract.

C. E. King's second Clinton County test, the No. 1 Vanderau, SE NE SW Section 18-55-31w, was a dry hole at reported depth of 1,832 ft. in Wilcox sand. Gas found at 600 ft., where it gaged 1,904,150 cu. ft., was to be taken by Morgan Hammond, who has the shallow field around Plattsburg under lease. The gas may be used by Central West Utility Co., which serves the town of Plattsburg.

In eastern Jefferson County, Kans., E. W. Mosbacher's No. 1 McLaughlin, SW NE NW Section 4-10-20, was reported to have found 2,000,000 cu. ft. of gas in Bartlesville sand at 1,430 ft., but operators were expected to drill ahead. OK Supply Co. completed a wildcat in Section 4-14-22, north of the Gardner pool, Johnson County, Kans., for 150,000 cu. ft. of gas daily. Completion of that well may be found in the Kansas field reports.

Blanket releases were filed last week by Carter Oil

*(Continued on Page 244)*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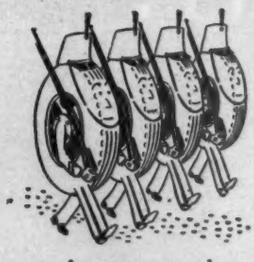

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MARMON-HERRINGTON *All-Wheel-Drive* FOR 1940

# Southwest Texas District

By F. L. SINGLETON

# Wildcats in 4 Counties Are Showing Encouraging Signs

CORPUS CHRISTI, Tex., Nov. 13.—Wildcat operations in the Laredo district provided the Southwest Texas district with an interesting week of developments as new pools were indicated for Duval, Jim Hogg, Starr and Webb counties. Other developments worthy of mention included new sand discoveries and extensions to the North Luby, Victoria and La Rosa fields.

Two miles southwest of the Hoffman field, Duval County, Magnolia Petroleum Co.'s No. 1 Weil estate, C.M.R.R. Survey No. 113, is bottomed at 2,806 ft. and 7-in. casing was cemented at 2,789 ft. after drill-stem testing showed promise of production. Broken sand with an odor of gas was cored at 2,644-61 ft., and on a 5-minute drill-stem test working pressure built up to 500 lb. Broken sand with an oil odor was cored at 2,786-2,806 ft. and a 40-minute drill-stem test recovered 100 ft. of oil-cut drilling mud.

In the eastern part of Duval County four interesting wildcats were staked along the Cockfield trend. Southeast of Benavides, Frank Gravis is moving in material for No. 1 Vaello in the Robert Fletcher Survey No. 7. Approximately 4 miles northeast of the Gravis location and 2 miles southwest of Guajillo, Rowan & Hope staked location for No. 1 Lopez, a projected 6,000-ft. test in the M. Lopez Survey. Two miles northeast of Rosita in the E. Garcia Survey, Taylor Refining Co. is moving in material for No. 1 Parr. J. B. Blanchard's No. 1 Lowe, east of the Labbe field, was abandoned at 3,502 ft. and the rig has been moved in for No. 1 E. A. Parr in the T. C. Rogers Survey.

### Jim Hogg County

In Jim Hogg County, approximately 10 miles southeast of Hebronville, Mayfair Oil Corp. was testing No. 1 Gutierrez which promises to open production from the Government Wells sand. A string of 5½-in. casing was cemented at 3,217 ft., after an 8-minute drill-stem test at 3,217-23 ft., the total depth, recovered 300 ft. of oily drilling mud. Sand with a good odor of oil was cored at 3,219-23 ft. Location is in the C. Gutierrez Survey No. 164.

Clopton, Mitchell & Zimmerman's No. 1 Seaberg, 5½ miles northeast of Rio Grand City, Starr County, looms as a probable pool opener as drill-stem testing showed favorable results. A 2-minute drill-stem test at 1,201-17 ft. tested 370 lb. of working pressure while a 30-minute test in the same sand section at 1,212-17 ft. showed no working pressure and 30 ft. of oily mud. A third test at 1,329-33 ft. tested 20 lb. working pressure and 55 ft. of oil, while a 12-minute test at 1,330-52 ft. tested 225 lb. pressure and 85 ft. of oily mud and salt water. At the close of the week the well was drilling ahead below 1,585 ft.

### Webb County

In Webb County O. W. Killam's No. 2 fee, Survey No. 1859, Block 16, cored sand at 1,318-28 ft. and at the close of the week a drill-stem test was made. Two drill-stem tests at 1,116-24 ft. and 1,237-46 showed a slight amount of oil and gas and fresh water.

With mechanical trouble delaying the progress of Anderson-Prichard Oil Corp. and Mills Bennett Production Co.'s No. 1 D. E. Robinson which has shown promise of opening Tertiary Wilcox production in the West Tuleta field, Bee County, interest for the time being shifted to Coronado Corp.'s No. 1 Heard, a wildcat 10 miles southeast of Beeville which is drilling ahead after a 4-minute drill-stem test showed 320 lb. of working pressure. Sandy shale with a gas odor was cored at 3,253-68 ft. In the West Tuleta area Anderson-Prichard Oil Corp. and Mills Bennett Production Co.'s No. 1 Robinson is bottomed at 7,660 ft. and the progress of the well has been delayed due to a fishing job which followed a third drill-stem test that tested 60 lb. working pressure and 225 ft. of gas-cut drilling mud. Previous testing in the sand section topped at 7,531 ft. showed as much as 305 lb. working pressure and some high-gravity oil.

Production from a deeper sand in the North Luby field, Nueces County, was indicated as Seaboard Oil Co.'s No. 4-A LaPrelle, flowed pipe-line oil and tested 20 lb. working pressure on a 14-minute drill-stem test at 5,079-85 ft., the total depth. Five and one-half inch casing was cemented on bottom. Broken sand and shale showing oil and gas was cored at 5,073-85 ft. The sand section is approximately 700 ft. deeper than the 4,300-ft. discovery zone.

### Refugio County

La Rosa field, Refugio County, was extended 1½ miles northeast as Morgan-Gulf Oil Corp.'s No. 1 J. M. Thomas jetted approximately 52 bbl. of oil daily from perforated casing at 6,250-57 ft.

The newly opened Victoria gas field, Victoria County, was extended approximately 2,000 ft. southwest by W. Boyles and others' No. 1 Simon estate. A drill-stem test at 2,529-64 ft. recovered 1 gal. of mud with an oily taste, while a 10-minute drill-stem test at 2,548-64 ft. tested 640 lb. working pressure and 30 ft. of sand with an odor of gas. The showing was logged in the discovery horizons, but the hole may be carried deeper in search of a new sand.

In the Ben Bolt field, Jim Wells County, Cox & Hamon were attempting to complete No. 1 Galveston Dry Goods Co. in the 5,400-ft. sand. Sand showing oil and gas was cored at 5,422-44 ft. and 5½-in. casing was cemented on bottom at 5,449 ft. H. H. Howell's No. 1 Johnston was completed in the regular pay at 5,201-04 ft. for an initial production of 288 bbl. daily, flowing through a ¾-in. choke.

In the East Alice area Gravis & Buescher's No. 1 Mil, 2,000 ft. northwest of production, flowed 65 bbl. per day through a 5/32-in. choke from perforated casing at 5,549-54 ft.

Along the Balcones Fault Line district John Vivian's No. 1 Louis Yeager, A.B.&M. Survey No. 53, is bottomed at 976 ft. and casing was cemented for a production test after sand with an oil show was cored at 966-76 ft., the total depth.

## COMPLETIONS IN PROVEN FIELDS

### Aransas-San Patricio Counties

McCampbell field: Texas Atlas Petroleum Corp.'s No. 1 Conn-Brown, perforated casing 7,142-47 ft., 127 bbl., ¾-in. choke.

### Bexar County

Alta Vista field: E. Rosenberg's No. 2 Kelso, 1,040 ft., temporarily abandoned. La Coste field: H. Lyles and others' No. 2 Wolford, 1,167 ft., dry and abandoned.

### Caldwell County

Luling field: Ruby Oil Co.'s No. 3 Putnam, 2,119 ft., temporarily abandoned.

### Calhoun County

Heyser field: Blanco Oil Co. and others' No. 16 Dunwoody, perforated casing 5,562-72 ft., 168 bbl., ¾-in. choke. Gulf Oil Corp.'s No. 26-B Traylor, 5,490 ft., 210 bbl., 3/32-in. choke.

### Duval County

Benavides field: Hiawatha Oil & Gas Co.'s No. 29 Parr, perforated casing 4,690-98 ft., 138 bbl., 5/32-in. choke. Hiawatha Oil & Gas Co.'s No. 16 Southland Life Insurance Co., perforated casing 5,508-13 ft., 30 bbl., jetting. Cedro Hill field: Texas Co.'s No. 30 Duval County Ranch Co., sand 1,428-38 ft., 63 bbl. fluid, 38 per cent salt water, jetting. Government Wells field: Magnolia Petroleum Co.'s No. 20 Wilson, 3,179 ft., dry and abandoned. Hoffman field: Cox & Hamon and others' No. 14 Cuellar, sand 2,671-79 ft., 83 bbl., jetting. Cox & Hamon's No. 16 Hoffman, perforated casing 2,753-56 ft., 69 bbl., jetting. Cuellar Brothers' No. 4-A fee, perforated casing 2,392-2,405 ft., gas well. Magnolia Petroleum Co.'s No. 49 Weil, sand 2,845-57 ft., 97 bbl., jetting. Longhorn field: Hiawatha Oil & Gas Co.'s No. 2 Denman, perforated casing 4,100-05 ft., 91 bbl., 5/32-in. choke. Lundell field: Government Wells Oil Co.'s No. 36 Lundell, sand 1,543-50 ft., 80 bbl., ¼-in. choke. Piedra De Lumbre field: Magnolia Petroleum Co.'s No. 42 Duval County Ranch Co., sand 2,164-67 ft., 350 bbl., ⅝-in. choke. Piedra Pintas field: A. & M. Well Service Co.'s No. 3 Dodge, 410 ft., dry and abandoned. Seven Sisters field: Wellington Oil Co.'s No. 2-G Welder, perforated casing 3,055-63 ft., dry gas well. Southland field: Hiawatha Oil & Gas Co.'s No. 3-A Southland Life Insurance Co., perforated casing 5,353-63 ft., 198 bbl., 5/32-in. choke.

### Goliad County

Fanning field: D. C. Mathews and others' No. 1 Swicheimer, 3,512 ft., dry and abandoned.

### Hidalgo County

Samfordyce field: Baldridge and others' No. 1 Chapa, perforated casing 3,929-31 ft., 10 bbl., ⅝-in. choke. Fohs Oil Co.'s No. 1-B Sheldon, perforated casing 2,863-68 ft., dry and abandoned.

### Jim Hogg-Brooks Counties

Kelsey field: Humble Oil & Refining Co.'s No. 30 McGill, 4,747 ft., 66 bbl., 13½ hours, 9/64-in. choke.

### Jim Wells County

Ben Bolt field: Bridwell Oil Co.'s No. 3-A Hoffman, perforated casing 5,227-33 ft., 109 bbl., 7/64-in. choke. H. J. Mosser's No. 3 Perales, perforated casing 5,419-23 ft., 278 bbl., ¾-in. choke. Magnolia field: V. J. Meyer and other's No. 2 Shear, 5,644 ft., dry and abandoned. South Alice field: Humble Oil & Refining Co.'s No. 1 Mull, 5,327 ft., 143 bbl., ¾-in. choke.

### Milam County

Rockdale field: H. H. Coffield's No. 1 fee, sand 1,330-38 ft., 17 bbl., pumping. Harry Moody's No. 1 fee, 780 ft., dry and abandoned.

### San Patricio County

East White Point field: Houston Oil Co.'s No. 4 fee, perforated casing 5,655-65 ft., 234 bbl., 5/32-in. choke. O. W. Killam's No. 4 Taft Syndicate, sand 5,997-5,605 ft., 133 bbl., ⅛-in. choke. Plymouth field: Plymouth Oil Co.'s No. 113-C Welder, perforated casing 6,140-47 ft., 168 bbl., 7/64-in. choke.

### Starr County

Rincon field: W. R. Davis Co.'s No. 2-B Slick, perforated casing 4,171-81 ft., 155 bbl., 5/32-in. choke. Ricaby field: Moss, Owens and others' No. 4 Ricaby, 1,338 ft., 8 bbl., pumping. Sun field: Sun Oil Co.'s No. 3 Speer, perforated casing 4,970-74 ft., 152 bbl. oil, 9 bbl. salt water, 5/32-in. choke.

### Victoria County

Cologne field: Houston Oil Co.'s No. 1 E. C. Dietzel, perforated casing 4,826-32 ft., gas well.

### Zapata County

Mirando Valley field: Interstate Minerals Co.'s No. 16 Lopez, sand 1,709-81 ft., 3 bbl., ⅝-in. choke.

## Oklahoma Fields

*(Continued from Page 225)*

### Creek County

J. E. Crosbie, Inc.'s No. 2 Mosquito, SE NW NE Section 20-17-9, was an abandoned location in Creek County.

W. M. Dunn and others' No. 3 Cantrell, NE SE SE Section 34-14-10, Dunn pool, Creek County, was drilling below 200 ft. after finding Checkerboard lime at 168-173 ft. It is a diagonal southeast offset of the newest producer in the area.

### Kay County

Burke's No. 2 Prunty, SW SE NW Section 33-28-3e, Mervine area, Kay County, was dry and abandoned at 1,364 ft., total depth.

### Okfuskee County

Hyer's No. 1 Board, SE SW NW Section 10-13-10, an old well in the Okfuskee pool, Okfuskee County, was deepened from 2,685 ft. to Wilcox sand at 3,400-16 ft., total depth, the hole filled with water and it was abandoned.

Machine was being rigged up at Aggis Drilling Co.'s No. 1 Miracle, NE NE NW Section 25-11-9, new test in Okfuskee County.

### Carter County

Ideal Oil Co.'s No. 15 Scoggins, NW SE SE Section 32-3s-3w, Fox pool, Carter County, was completed for 12 bbl. of oil daily after plugging back to 1,180 ft. from 1,183 ft., total depth.

Gulf Oil Corp.'s No. 2 McClure, C SE NE Section 28-2s-3w, an old well bottomed at 7,930 ft., was preparing to plug back and perforate.

### Caddo County

Ohio Oil Co. and others' No. 10 Pau-Kune, NE SE SW Section 3-5-9w, Cement field, Caddo County, was completed for 24-hour potential of 3,362 bbl. of oil. It had Rowe sand at 3,347-86 ft., and another sand at 3,553-78 ft., total depth. It was plugged back to Noble-Olson sand topped at 3,247 ft., casing was perforated at 3,346-85 ft. and it flowed 219 bbl. in 2 hours and was shut in.

Magnolia Petroleum Co.'s No. 7 Pau-Kune, SW NE NE Section 10-5-9w, an old well, was deepened from 2,437 ft. to sand at 3,345-3,468 ft., total depth, flowed 91 bbl. of oil in 4 hours and was shut in. It had not been completed.

### Oklahoma County

Keriyn Oil Co.'s No. 1 College, NE NW SW Section 21-13-3w, south of the Orphanage extension area in the Britton sector, Oklahoma County, topped Wilcox sand at 6,690 ft. and was completed at total depth of 6,760 ft. It flowed 171 bbl. of oil in 21 hours, with 6,000,000 cu. ft. of gas.

### Jackson County

Gulf Oil Corp.'s No. 1 Inkleburger, SW SW SW Section 3-1n-20w, Altus field, Jackson County, topped Cisco formation at 1,857 ft., drilled to 2,136 ft., plugged back to 1,247 ft. and was abandoned temporarily.

Kerbow's No. 3 Leona, SW SW SE Section 31-1n-19w, Tipton pool, was an abandoned location.

New work in Jackson County: Burnham's No. 6 Sumner, SE NW SE Section 6-1s-19w, drilling below 700 ft.; Kerbow's No. 2 Hunter, NW NW SW Section 6-1s-19w, drilling below 742 ft.

In Kiowa County, Phillips Petroleum Co.'s No. 1 Warner, NE NE SE Section 19-7-17w, was rigging up machine.

## Ohio Fields

*(Continued from Page 239)*

Downie's No. 1 Edward Renter, Section 29, made 3 bbl. of oil and 60,000 cu. ft. of gas from first Cow Run at 395-98 ft. The well was not shot.

Noble County, Beaver Township, Ohio Fuel Gas Co.'s No. 3 M. W. Conservancy District, Section 32, made 85,000 cu. ft. of gas from Berea at 1,396-1,402 ft.

Washington County, Fairfield Township, A. R. McKitrick and others' No. 1 Vida A. McVicar, Section 8, gaged 240,000 cu. ft. of gas from the Salt sand at 1,135 ft.

### Lima Field

In Putnam County, Blanchard Township, Dibble Oil & Gas Co.'s No. 1 Charles Harmon, Section 28, was drilled 44 ft. into the Trenton sand and shot with 120 qt. It made some oil and a little water and was estimated as a 5-bbl. well; top of Trenton 1,326 ft., total depth 1,370 ft.

In Franklin County, Madison Township, Section 15, Blacksten and others bailed 4 bbl. of oil in 16 hours from their test on the E. J. Simms land. The oil showing was found in the lower portion of the Trenton and was treated with acid. Another acid treatment will be given in the near future.

## Forest City Basin Activity

*(Continued from Page 242)*

Co. in various counties in Missouri, Kansas and Nebraska. In Missouri the company dropped 108 leases in Buchanan County, 100 in Andrew County, 645 in Atchison County and 550 in Holt County. It is reported to have released 610 tracts in Doniphan County, Kansas, as well as numerous leases in adjacent Brown County. It let go 16,000 acres in Richardson County, Neb. Tracts which showed favorable on seismograph or geology are being retained by the company, with some scattered checkerboard leases. The company is drilling a slim hole rotary core test in Section 24-4-16, about 4 miles northwest of Horton, Brown County.

## El Paso Natural Gas Co.

### Report on Earnings

The report of El Paso Natural Gas Co. (Delaware) and subsidiaries for the 12 months ended September 30, 1939, shows net income, after all charges including provision for retirements, interest, amortization of debt expense and federal income taxes, but before provision for surtax on undistributed profits, of $2,467,118, compared with $1,952,580 for the 12 months ended September 30, 1938, an increase of $514,537, or approximately 26 per cent. The balance of net income remaining for common dividends and surplus, after payment of preferred dividends of $103,579, was $2,363,539 for 1939, equivalent to approximately $3.93 per share on 601,594 shares of $3 par common stock outstanding at the close of the period, against $1,849,001, or approximately $3.10 per share on 595,942 shares outstanding for the September 30, 1938, 12 months.

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# North Louisiana, Arkansas

By GEORGE WEBER

# Arkansas Wildcats Nearing Crisis; Lisbon Test Delayed

SHREVEPORT, La., Nov. 11.—The Lisbon field of Claiborne Parish, Louisiana, continued as the center of attention in the Ark-La-Tex area, although production tests of lower Marine horizons were postponed throughout the week due to mechanical difficulties. The deep test, Lisbon Exploration Co.'s No. 1 Vaughn was shut down over the week end, with a string of 5-in. casing set at 8,881 ft. and a perforator stuck in the hole. During the past week the well was perforated with 116 shots at 8,354-83 ft. in the upper of two horizons which have shown good production possibilities. Following the shot the gun became stuck in the hole and was pushed to the bottom at 8,900 ft. Plans were originally to test the sand section shot and then to fish further for the perforator, but latest reports are that fishing will continue this week, and another test will be made after the "fish" is recovered or abandoned.

Another sand section at 8,449-55 ft. showed production possibilities and was checked by a Schlumberger survey. Both horizons are in the lower Marine formation which is producing gas, distillate and oil in the prolific Cotton Valley field of Webster Parish.

### Monroe Test in Salt

The Union Producing Co.'s No. 1-A Tensas, a deep test on the north flank of the Munroe gas field in Morehouse Parish, has drilled through the salt and at latest reports was below 9,200 ft. in anhydrite. The top of the salt was logged at 8,114 ft. and the base is reported at 9,081 ft.

A second deep test to drill into the salt this week is Stanolind Oil & Gas Co.'s No. 131 Dillon heirs, which topped the salt at 10,160 ft. and is drilling ahead below 10,220 ft. This well is the deep Pine Island test in Caddo Parish, which is being drilled "tight." Although unverified, it is reported that tubing is being moved onto the location, possibly for a test of some horizon considered productive. No showings of any importance have been reported from the well which has 7-in. casing set at 10,154 ft.

In addition to Pine Island, three other areas in the vicinity of Shreveport were of interest this week. To the south of the Broadmoor subdivision David Crawford's No. 1 Lloyd failed to show any indication of oil in the Pettit lime after missing the Jeter last week. After encountering shale and some dense lime in the Pettit horizon, the test is drilling below 5,850 ft., with coring for the Travis Peak formation due to begin shortly.

West of Shreveport an east outpost to the Waskom gas-condensate field, Arkansas Louisiana Gas Co.'s No. 1 Bell, is bottomed at 6,400 ft. with 5½-in. casing set at 6,169 ft. A drill-stem test earlier in the week at 6,157-79 ft. showed drilling mud. Operators will perforate for production in the Pettit lime zone at 5,627-77 ft., where 20,000,000 cu. ft. of gas was tested on the drill stem.

In the Caddo area, northeast of Vivian, the completion of Temple Oil Corp.'s No. 1 Bostwick in a wildcat location 2 miles north of nearest production brought three new locations for additional development. Drilling is expected to revive in the area as it did several months ago with the discovery of shallow production near Vivian. The discovery well is producing from the Woodbine sand at 2,548-58 ft.

## NORTH LOUISIANA COMPLETIONS

### Caddo—Caddo Parish

J. G. Bailey and others' No. 2-A Muslow, Section 17-20-15, salt water and abandoned, total depth 2,221 ft. Burnham Drilling Co.'s No. 1 Hurdle, Section 34-22-16, salt water and abandoned, total depth 2,510 ft. R. Manziel's No. 1 Brooks, Section 17-21-15, salt water and abandoned, total depth 1,115 ft. J. G. Mechon's No. 1 Crystal, Section 14-21-16, salt water and abandoned, total depth 1,697 ft. Claude L. Nell's No. 1 Vaughn, Section 1-20-16, pumping 25 bbl. of oil, total depth 1,550 ft.

### Bellevue—Bossier Parish

Gary & Gibson's No. 1-A Connell, N½ SE SE Section 15-19-11, pumping 12 bbl. oil and 25 bbl. salt water, total depth 390 ft.

### Shreveport—Caddo Parish

C. H. Lyons' No. 1 Rosenblath, 725 ft. north and 1,270 ft. east of C Section 35-18-14, 400 bbl., ¼-in. choke, tubing pressure 350 lb., casing pressure 900 lb., 5½-in. casing 5,591 ft.. total depth 5,599 ft.

### Zwolle—Sabine Parish

Oglesby & Baird's No. 1 Sabine Lumber Co., SW SE Section 5-7-13, 450 bbl., open tubing, 6-in. casing set at 2,165 ft., total depth 2,481 ft.

### Monroe—Union Parish

Memphis Natural Gas Co.'s No. 2 Frost Lumber Ind., Section 22-22-3, 2,000,000 cu. ft. gas, rock pressure 1,020 lb., total depth 2,202 ft. H. L. Woods' No. 1 Frost Lumber, Ind., Section 29-21-3, 1,500,000 cu. ft., rock pressure 960 lb., total depth 2,195 ft. Southern Carbon Co.'s No. 33 Grayling, Section 30-22-4, 3,000,000 cu. ft. gas, rock pressure 1,020 lb., total depth 2,200 ft.

### Arkansas

In Columbia County, Arkansas, two Standard Oil Co. wildcats are gaining added attention as they approach critical depths. No. 1 C. F. Petty Stave & Lumber Co., in the Big Creek prospect in Section 4-17-21, northwest of the town of Magnolia, is drilling hard lime and shale below 6,118 ft. after topping Travis Peak at 4,520 ft. In the Warnock Springs district No. 1 R. S. Warnock, Section 36-16-20, east-northeast of Magnolia, is drilling sand and shale below 5,946 ft. These tests will be closely watched as they approach the Smackover lime which is producing in several Columbia and Union County fields. A third important wildcat, Barnsdall Oil Co.'s No. 1 Cameron, in Section 36-19-17, near Junction City, Union County, is rigged up for a test of the Smackover lime.

With drilling in the Magnolia field of Columbia County on the wane, activity is increasing in two other Smackover lime pools, later discovered in the county. In the Dorcheat field four drilling wells are active and the Atlanta field has three wells drilling.

## ARKANSAS COMPLETIONS

### Magnolia—Columbia County

Arkansas Fuel Oil Co.'s No. 1-A King, C SE SW Section 16-17-20, 360 bbl., ¼-in. choke, tubing pressure 1,400 lb., casing pressure 1,550 lb., casing perforated at 7,650-80 ft., total depth 7,697 ft.

### Buckner—Lafayette County

Standard Oil Co. of Louisiana's No. 2 H. B. Eddy and others, C SE SE Section 12-16-23, 1,920 bbl., ¾-in. choke, tubing pressure 170 lb., 6-in. casing 7,262 ft., total depth 7,287 ft.

## EAST TEXAS BORDER COMPLETIONS

### Rodessa—Marion County

Arkansas-Louisiana Gas Co.'s No. 2 W. T. Neilson, 1,320 ft. from the north line and 620 ft. from the southeast line of the Bennington Survey, 31,000,000 cu. ft. of gas on open flow. Tubing and casing pressures 1,800 lb., perforated casing at 5,900-44 ft., total depth 5,983 ft. Texas Co.'s No. 6 Braden, J. M. Fitzgerald Survey, 715 bbl. per day through 20/64-in. choke, tubing pressure 550 lb., casing pressure 1,050 lb., total depth 6,014 ft.

### Joaquin—Shelby County

Natural Gas Distributing Co.'s No. 1 W. D. Childress, W. M. Snider Survey, gas-condensate well, no gage obtained, 5-in. casing set at 5,080 ft., total depth 5,131 ft.

### Mississippi

Continued leasing and blocking in the Vicksburg-Jackson area of Mississippi brought new wildcat locations in the past week, as the interest in the Tinsley field temporarily subsided. The north-edge test, Union Producing Co.'s No. 1 Stevens, drilled into a colored oil sand at 5,493-5,508 ft., but a drill-stem test at 5,486-5,508 ft. showed 3,800 ft. of salt water in 13 minutes, and the test is coring ahead in the Tuscaloosa formation. This is the test which cored and tested a good oil-sand section in the Eutaw formation below the present productive horizon in the field.

Two tests in the field were expected to drill the pay over the week end. Union Producing Co.'s No. 1 Friley, west of the discovery, and Jones & O'Brien Brothers' No. 2 Stevens, east-edge test, were the prospective new producers.

### Production by Pool

Estimated daily gross production all companies week ended November 8, 1939:

**NORTH LOUISIANA**

| | |
|---|---|
| Bellevue | 480 |
| Caddo light | 5,220 |
| Caddo heavy | 2,510 |
| Converse | 580 |
| Cotton Valley light | *11,105 |
| Cross Lake | 5,110 |
| De Soto and Red River | 1,075 |
| Elm Grove | 300 |
| Haynesville | 2,755 |
| Holly | 85 |
| Homer | 2,745 |
| Lisbon | 5,510 |
| Pleasant Hill | 85 |
| Rodessa | 21,470 |
| Sarepta-Carterville | †285 |
| Sligo | 1,210 |
| Sugar Creek | 295 |
| Urania | 2,540 |
| Zwolle | 2,455 |
| Total | 65,815 |

**SOUTH ARKANSAS**

| | |
|---|---|
| Atlanta | 370 |
| Buckner | 2,455 |
| Champagnolle | 1,375 |
| Dorcheat | 200 |
| El Dorado | 1,600 |
| Lewisville | 1,000 |
| Lisbon | 240 |
| Magnolia | 19,485 |
| Miller County | 300 |
| Nevada | 550 |
| Rodessa | 3,070 |
| Schuler | 18,020 |
| Smackover light | 1,885 |
| Smackover heavy | 14,490 |
| Stephens | 535 |
| Troy | 1,270 |
| Urbana | 990 |
| Village | 1,135 |
| Total | 68,970 |

*2,505 bbl. is distillate. †103 bbl. is distillate. Texas side of Rodessa field, 26,510 bbl.

### Salt Creek Royalty Bids

WASHINGTON, D. C., Nov. 11—The Interior Department asked for bids December 1 for purchase of government royalty oil from Salt Creek, Wyoming, for 1, 3 or 5 years after January 1, 1940.

# Eastern Field Report

By STAFF CORRESPONDENT

# New Oriskany Gas Field to See Immediate Development

PITTSBURGH, Pa., Nov. 13.—A deep test is starting in Jackson County, West Virginia, where Joe Rubin and others will drill on the Henry Morrison farm in Grant district and it is scheduled for the Oriskany sand. It will be a north offset to the Oriskany gas well on the D. P. Curry farm in Ravenswood district and is in the center of the farm.

The new test will be about 2 miles west of the town of Lockhart near the Grant-Ravenswood district lines. In the D. P. Curry test, the Oriskany sand was topped at 4,045 ft. subsea and had a volume of 2,425,000 cu. ft. a day after a shot with a rock pressure of 1,900 lb. in 30 hours. It was the initial test in what is expected to be a new gas field.

## SOUTHEAST OHIO

In Coshocton County, southeastern Ohio, Preston Oil Co. completed No. 2 Rine in Section 15, Perry Township, in Clinton sand at 3,200 ft. It was estimated good for 50 bbl. a day after the shot.

In Athens County C. W. Nuzum and others drilled a dry hole on the Lewis Warren farm at Canaanville in Section 1, Canaan Township, through the first Cow Run sand to 298 ft.

In Columbiana County C. W. Thompson and others drilled a dry hole on the J. L. Pieren farm in Section 15, West Township, through Berea sand to 720 ft.

In Guernsey County H. A. Burns and others' test on the Muskingum Watershed Conservation district, in Section 13, Richland Township, was a dry hole in the Germantown sand at 445 ft.

In Licking County Rex Roth Oil Co. completed No. 3 S. E. Waipole in Section 23, Madison Township, in Berea sand at 771 ft. and it is good for 5 bbl. a day. In Section 7, Perry Township, G. F. Earley and others completed a 4-bbl. well on the Fairall Brothers lease in the Berea sand at 693 ft.

In Medina County Marine Trust Co. completed No. 1024 Daniel Ross, Tract 13, Lot 7, Chatham Township, in Berea grit at 479 ft., and it produced 25 bbl. the first day after shot. These operators drilled No. 108 on the W. A. Shaw farm in Berea to 459 ft. and it will be used as an input well for repressuring. It is in Tract 10, Lot 5, same township.

In Muskingum County Atha Oil Co. completed a test on the G. B. Gibson farm, Section 16, Union Township, through the Squaw sand to 772 ft. It was dry.

## SOUTHWEST PENNSYLVANIA

In Armstrong County, Pennsylvania, Peoples Natural Gas Co. is drilling at 1,760 ft. in the William Small test and at 1,560 ft. in the Frances Harkleroad test. The Apollo Gas Co. is building rig on the Hulda Bleakney farm. Equitable Gas Co. will drill on the D. W. Raraigh farm. Louden Drilling Co. is drilling at 3,190 ft. and deepening the A. G. Schaeffer test. T. W. Phillips Gas & Oil Co. is spudding on the Jacob Boyer heirs' farm. All are in Cowanshannock Township.

In Boggs Township John Wray and others are drilling at 795 ft. on the William Mateer farm and rigging up on the Walter Upperman farm. In Kiskiminitas Township, Apollo Gas Co. is rigging up on the A. D. Tressler farm.

In Kitanning Township Judson and others are drilling at 1,304 ft. in No. 2 W. J. Gray, and Edward Young has a location on the Hugh Blair farm. In Manor Township John Wray and others started drilling on the David Campbell heirs' farm. William McCollins has started drilling on the Add Reefer farm, in Plum Creek Township. In South Bend Township the Shelocta Oil & Gas Co. is drilling at 726 ft. in the Harve Reefer test.

In Clarion County T. Schwartsfager and others have rigged up on the William George farm in Limestone Township. In Red Bank Township Owens-Illinois Glass Co. is drilling at 2,500 ft. in the Lewis Keck test.

In Indiana County T. W. Phillips Gas & Oil Co. is drilling at 679 ft. in the Samuel Pool test in Brush Valley Township; at 1,812 ft. on the Federal Land Bank lease in Cherry Hill Township, and at 805 ft. on the F. B. Lonman farm in White Township.

In Westmoreland County Peoples Natural Gas Co. completed a small gas well on the Asa Blose farm in Washington Township at 3,909 ft., producing from the Elizabeth, Speechley, and Bradford sands. In Allegheny Township this company is shut down at 4,204 ft. in No. 1 R. H. Miller. Apollo Gas Co. is building a rig on the D. M. Jones heirs' farm. In Bell Township, Kiski Valley Gas Co. is fishing at 2,240 ft. in No. 1 James McBriar, and spudding on the John Beighley farm.

### Fayette-Greene

In Nicholson Township, Fayette County, Greensboro Gas Co. is drilling at 1,172 ft. on the Mary Oravis farm. The Duquesne Gas Co. is drilling at 1,057 ft. in the Agnes Kirk test. In Menallen Township J. H. Carnell is drilling at 1,915 ft. on the Mike Uhrin farm.

In Washington Township, Greene County, Equitable Gas Co. is rigging up on the W. L. Beabout farm. In Richhill Township Natural Gas Co. of West Virginia is drilling at 417 ft. ni the Robert Burns test. In Greene Township Fred Garrison is down 1,170 ft. in the Henderson Coal Co. test.

### Washington County

In South Franklin Township, Washington County, Union Gasoline & Oil Corp. is spudding No. 826 C. T. Conn farm. A. V. Lewis and others are rigging up on the L. W. Phelan farm, and are shut down at 1,618 ft. at No. 16 J. Frank Wilson. E. H. and J. B. Tague are rigging up on the J. O. Peticord test. Harry Williams & Co. is drilling at 550 ft. in No. 5 Jason Buchanan, and Foley and Williams at 200 ft. in No. 2 John G. Clark.

In Amwell Township Shivers & Co. have reached 1,610 ft. in the Thomas J. Horn test. In Morris Township Brummage and others are drilling at 2,575 ft. in No. 821 on the J. Jones farm. Union Gasoline & Oil Corp. is drilling at 2,475 ft. in No. 821 J. R. Andrews, and at 1,317 ft. in No. 824 H. A. Day.

In Allegheny County Homer Nixon is drilling at 1,190 ft. in the James Hickman test in South Fayette Township, and Cox & Gibson have reached 1,855 ft. on the William M. Patterson farm in the same township.

### Deep Tests

On Chestnut Ridge in Fayette County New Penn Development Co., William E. Snee and others are drilling at 6,260 ft. on the Piedmont Coal Co. lease in North Union Township, having passed through the bailer lost at 6,120 ft. The Onondaga should be reached within the week. In Maryland these operators are drilling at 3,293 ft. on the Humberson farm in the Accident dome in Garrett County. In Fayette County New Penn and E. G. Mueller are drilling at 250 ft. on the Gregg L. Neel farm on Laurel Ridge in Stewart Township.

In North Union Township, Fayette County, Wasson & Co. have started drilling No. 2 J. H. Sorg. About 4 miles of line has yet to be completed from Point Marion, Pa., to start taking gas from No. 1 on this farm.

## WEST VIRGINIA

Several small oil wells were completed in West Virginia during the week. In Clay County Virginian Gasoline & Oil Corp. completed No. 1274 Brown, Swann, and Goshorn in Henry district at 1,757 ft., Injun sand, and it is good for 10 bbl. a day along with about 475,000 cu. ft. of gas.

In Marshall County Clara Moore completed No. 3 D. H. Arrick in Franklin Township at 1,695 ft., with the Keener sand topped at 1,683 ft. and about 3 bbl. a day at 1,691-92 ft.

In Pleasants County Snider and Nohe completed the test on the T. C. Hammett farm in Jefferson district in the Squaw sand at 2,030 ft., and it is good for 2 bbl. a day.

In Roane County Rogers Properties Co. completed a well on the J. R. Cooper farm in Curtis district at 1,851 ft., with the Salt sand topped at 1,813 ft.; oil 1,828-48 ft.; and about 2 bbl. a day after a 60-qt. shot.

### Gas Wells

In Cabell County Carl Henderson and others completed a gas well on the W. N. Clay farm in Barboursville district at 3,258 ft., in Brown shale, and it gaged 220,000 cu. ft. a day 24 hours after two shots.

In Doddridge County Pittsburgh & West Virginia Gas Co. deepened No. 4658 W. Brent Maxwell, in Southwest district; gas at 1,894-96 ft.; gaged about 71,000 cu. ft. a day.

In Gilmer County Rock Creek Oil Co. completed a small gas well on the D. M. Miller heirs' farm in DeKalb district, at 1,935 ft. It produced 31,000 cu. ft. of gas without shot at 1,876-90 ft. A. E. Ellis completed a second test on the Cal C. Pickens farm in Salt sand at 1,423 ft., with a gage of 100,000 cu. ft. a day.

In Logan County Boone County Coal Corp. completed No. 16 fee in Logan district at 1,950 ft., the Big lime, and it is gaging 350,000 cu. ft. a day.

In Pleasants County G. A. Smith & Co. have a gas well on the Flora B. Lamp and others' lease in Lafayette district in the Injun sand at 1,967 ft., and it gaged 53,000 cu. ft. a day.

In Roane County R. W. Healy completed a second test on the Jarrett Ferrell farm in Harper district at 1,580 ft. with Salt sand topped at 1,450 ft. and 40,000 cu. ft. of gas, natural flow, at 1,550 ft. In Spencer district Boggess & Dodd completed a dry hole on the B. L. Mullins (M. L. Vandevender) farm at 1,520 ft.

In Tyler County Neeley Oil & Gas Co. drilled a dry hole on the Gorman heirs' farm in Union district, through Injun sand to 1,665 ft. In Wood County M. W. Athey and others' No. 14 Elizabeth Ogden, in Williams district, was drilled through the second Cow Run sand to 875 ft. and was dry and abandoned.

### Oriskany Gas Field

There were three completions in the Oriskany gas field in Kanawha County. In Poca district Columbian Carbon Co. on the H. H. Parsons farm drilled to 5,092 ft., with Oriskany sand at 5,018-87 ft., and the well gaged 794,000 cu. ft. a day. This company completed cleaning out the Tignor and Griffith test after a shot and it gaged 442,000 cu. ft. a day, with total depth 5,154 ft., plugged back to 5,086 ft.

In Elk district this company completed a gasser on the Tignor and Jordon farm at 5,185 ft. with the Oriskany at 5,098-5,180 ft. and a gage after the shot of 1,157,000 cu. ft. a day. It had not been totally cleaned out.

In Poca district United Carbon Co. made a location on the Louisa E. Long farm; is drilling at 3,265 ft. in the E. P. Higginbotham and others test, and is rigging up No. 815 W. J. Bumgardner.

In Poca district Columbian Carbon Co. is drilling at 4,400 ft. in No. 2 H. H. Parsons; at 2,010 ft. in the John Price test; at 1,845 ft. on the B. H. Richards land; at 1,400 ft. in the Walter Payne test; at 715 ft. on the W. S. Jones farm. The Brawley-Reid Gas Co. is down 4,565 ft. on the Clate Fisher farm and at 1,475 ft. in the J. F. Jordan test. United Fuel Gas Co. is drilling at 1,580 ft. in No. 4858 Mattie J. Krantz, Malden

*(Continued on Page 248)*

# Canadian Fields

## Completions and Operations in Northwest and in Ontario

By VICTOR LAURISTON

CHATHAM, Ont., Nov. 11.—Crude petroleum and natural gasoline production from all Canadian fields in August is officially reported at 795,844 bbl., a daily average of 25,672 bbl., compared with 899,169 bbl. in July or 29,005 bbl. daily, and 825,546 bbl., 26,631 bbl. daily, in August 1938. For the first 8 months of 1939 production aggregated 5,066,251 bbl., an average of 20,849 bbl. daily, compared with 4,448,837 bbl. for the same period last year, an average of 18,308 bbl. per day.

New Brunswick production for the month increased from 2,684 bbl. in July to 4,135 bbl. in August, but was 13,087 bbl. for the 8 months of 1939 against 14,859 bbl. for the 1938 period. Ontario production was up from 17,175 bbl. in July to 20,545 bbl. in August and increased from 109,783 bbl. in 8 months of 1938 to 138,706 bbl. in the 1939 similar period. Alberta's output dropped from 877,005 bbl. in July to 767,984 bbl. in August but increased from 4,306,636 bbl. in January-August 1938 to 4,899,258 bbl. in the same period in 1939. Production from the Fort Norman field in the Northwest Territories was 5,015 bbl. in August 1939 compared with 2,305 bbl. in July and 7,731 bbl. in August 1938. For the 1939 operating period to the end of August, Fort Norman produced 15,200 bbl. against 17,559 bbl. the previous year.

### Completions and Tests in Lime

The Alberta Conservation Board has assigned a daily allowable of 763 bbl. to Royalite Oil Co.'s No. 42, LSD 4, Section 32-18-2w5, making it the second largest producer in the field, next to Home-Millarville's No. 2, with an allowable of 859 bbl. daily. Royalite 42 displaces Anglo-Canadian's No. 6, now ranking third with allowable of 696 bbl. daily.

In the same section British Colonial Oils' No. 1, LSD 5, was increased from 225 bbl. to 417 bbl. daily allowable, following treatment and an improved gas-oil ratio.

Anglo-Canadian Oil Co.'s No. 8, LSD 11, Section 7-19-2w5, showed 89 bbl. in the first hour on drill-stem test at a depth of 7,788 ft. in the Madison, and is being acidized with 5,000 gal. in the lower porous. It is about 1 mile northwest of the nearest producer, East Crest No. 5.

Okalta Oil Co.'s No. 7, LSD 3, Section 16-18-2w5, is below 7,116 ft. after getting the Madison at 6,970 ft. When the middle hard zone is reached 7-in. string will be cemented. In Section 22-20-3w5, Royalite Oil Co.'s No. 43, LSD 2, is cementing casing at 8,306 ft. after getting the Madison at 8,291 ft.

### West Turner Valley Operations

The location recently given to Royalite's new well, No. 48, LSD 12, Section 27-20-3w5, in North Turner Valley, has been changed to LSD 10, Section 7-19-2w5, in the west central field. Drilling permit for another new well in the same section has been issued by the Alberta Conservation Board to the Anglo-Canadian Oil Co. Anglo-Canadian's No. 9 is located on LSD 14, Section 7-19-2w5, in the same section as its No. 8 which is on test now and promises to be a good producer.

In Section 13-19-3w5 Arrow's No. 1, LSD 16, is below 2,902 ft. in the Belly River formation. In the same section Alliance Royalties' No. 1, LSD 9, has derrick up.

### Far South Drilling

North-West-Hudson's Bay Co.'s No. 2, LSD 9, Section 8-18-2w5, is below 6,742 ft. in the Blairmore.

### In the North

Anglo-Phillips' No. 1, LSD 14, Section 15-20-3w5, is below 1,805 ft. in the Belly River formation. A new well to be drilled on the location, LSD 12, Section 27-20-3w5, recently given for Royalite's No. 48, which is being drilled in the center field instead, will be known as Foothills No. 5.

### Ontario Oil Fields

T. J. Munroe and J. W. Mowbray, of Detroit, are drilling a test for shallow crude ½ mile south of the location of the old Gurd gusher in Raleigh Township, Kent County. Before starting the new test the Munroe-Mowbray interests cleaned out and reconditioned an old well, which is developing a fair pumper. The Gurd gusher, drilled in 1902 in that area, started with a spectacular shallow production of 1,000 bbl. a day, but the field was later abandoned. The Munroe-Mowbray interests are employing a new electrical seismographic device invented by Mr. Mowbray and which will be employed in extensive operations the syndicate is planning.

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# Michigan Field Report

By
O. C. PRESSPRICH

# New Pipe Line Will Utilize Gas Wasted in Kent County

SAGINAW, Mich., Nov. 13. — Utilization of casing-head gas now largely wasted in the Walker and Wyoming fields of Kent County is contemplated through construction of a $100,000 gas pipe line. The project was approved last week by the Michigan Public Service Commission.

The proposed line for West Michigan Consumers Co., supplier of industrial plants in the Muskegon area, would bring the casing-head gas to the terminal of the company's present line, which taps Muskegon County's Ravenna field. It is estimated half the gas now wasted could be utilized, the rest stored at Ravenna. The plan provides for a drying plant and the eventuality of supplying natural gas for the city of Grand Haven.

One new gas well was completed in Clare County's Lincoln Township last week, along with completion of 18 oil wells which added 7,200 bbl. to the state's daily potential production. Fourteen other oil tests were abandoned as dry holes and there also was a gas-test failure.

### Walker Pool Leads

Bulk of the new production was in the proven Walker field and its Ottawa County extension, although a few failures in the area indicated that the limits of the currently most prolific Michigan field are being definitely established.

Two of the eight Walker completions were dry holes while the new oil wells ranged from 1,200 bbl. down to 4 bbl. per day. Best well was Basin Oil Co.'s No. 3 Wildeboer in Section 31, its 1,200-bbl. potential being equaled by Gulf Refining Co. producing division's No. 1 Marquette-State, in Section 29, Redding Township, Clare County.

Smith Petroleum Co. got a 600-bbl. well in Walker's Section 33, while in adjacent Wyoming Township there were two new oil wells and a dry hole, one of the wells, the Lamar Oil Co.'s No. 4 Grand Rapids Gravel Co., having initial after-acid potential of 700 bbl. per day. However, there was a rapid decline in productivity after 2 or 3 days.

Ottawa's Tallmadge area was further developed with good results as Edward B. Strom and Twin Drilling Co. each completed a well in Section 25, getting after-acid potential of 960 bbl. in each case.

### Isabella's Revival

What amounts to a mild boom for a Central Michigan area is occurring in Isabella County, where Turner Petroleum Co. completed No. 1 Dennis in Section 28 for 235 bbl. a day after an acid treatment. Another test in the township was being tested and four other drilling projects were at various stages. The Dennis well is a southwest offset to the Wise pool discovery well.

Pure Oil Co., which completed a small well in Redding of Clare, suffered a fire loss on its State-Sparrow lease, a battery of storage tanks and a treating tank being razed, damage amounting to about $6,000. Five tanks and 700 bbl. of oil were destroyed.

Allegan County activity added four oil wells to the area while two tests were abandoned. Three of the wells are in Salem, the other in Overisel Township. Van Buren County continued its decline as failures were recorded in Bangor and Columbia townships.

Wildcatting appeared rather dull in Central Michigan and there were scattered failures during the week. A test was abandoned in Winterfield Township, Clare County, in Portage of Kalamazoo, in Caledonia of Kent, in Jamestown of Ottawa. However, prospecting interest continues with numerous new locations included in the weekly drilling-permit list. The state Conservation Department issued franchises for 28 tests in 13 counties. While 11 of the number were for Kent County, the list showed tests scheduled for all sections of the Lower Peninsula.

Following is a summary of completions:

### Allegan County

Allegan Township (2n-13w)—Vahue & Wray's No. 1 Eugene C. Smith, SE NW SW Section 11, dry and abandoned at 1,507 ft.

Hopkins County (3n-12w)—Bell & Marks, Inc.'s No. 1-B Parmalee estate, NE SE SE Section 22, a dry hole, abandoned at 1,651 ft.

Overisel Township (4n-14w)—E. P. Wyman, trustee's No. 1 Albert Vander Poppen, NW NW SE Section 27, rated 150 bbl. a day, naturally, being completed at a depth of 1,475 ft.

Salem Township (4n-13w)—Voorhees Drilling Co.'s No. 3 Loew, NW SE SW Section 3, failed to produce, and was abandoned at a total depth of 1,685 ft. Salem Gas & Oil Co.'s No. 3 John and Lucreta Gaca, SE NW SW Section 14, rated at 240 bbl. a day after acid treatment, total depth 1,594 ft. Michigan Devonian Petroleum Co.'s No. 3 Lawrence R. Green, NE SW SE Section 15, completed at 1,571 ft., rated 350 bbl. a day after an acid treatment. Gulf Refining Co. producing division's No. 2 Zerfas, SE SE NE Section 15, completed at 1,593 ft., 58 bbl. a day, after acidizing.

### Arenac County

Lincoln Township (18n-4e)—Chief Oil & Gas Co.'s No. 1 Peter Koelsch, NW NW NW Section 16, was abandoned at 2,923 ft.

### Clare County

Lincoln Township (18n-5w)—Producing 10,900,000 cu. ft. of gas a day, American Production Co.'s No. 2 Ann Arbor Railroad Co., C SW¼ Section 21, was completed at total depth of 1,516 ft.

Redding Township (19n-6w)—Gulf Refining Co. producing division's No. 1 Marquette-State, C S½ SE NE Section 29, was good for 1,200 bbl. at a total depth of 3,859 ft., for the best well of the week. Pure Oil Co.'s No. 1 William Kubat, SW SW NE Section 27, rated only 29 bbl. after an acid treatment, its completion depth being 3,897½ ft.

Winterfield Township (20n-6w)—Sun Oil Co.'s No. 1 Frank C. Davis, C S½ NE SE Section 16, a wildcat test, was abandoned as a dry hole at 3,908 ft.

### Clinton County

Dewitt Township (5n-2w)—Clinton Petroleum Co.'s No. 1 William Loesch, SE SW SW Section 18, was a wildcat failure; drilling halted at a depth of 2,925 ft.

### Isabella County

Wise Township (16n-3w) — Turner Petroleum Co.'s No. 1 C. Dennis, NW SE NW Section 28, completed at 3,705½ ft., was good for 235 bbl. a day after an acid treatment.

### Kalamazoo County

Portage Township (3s-11w)—M. Bliss Keeler's No. 1 Blanchard wildcat, SW NW SW Section 31, a dry hole, was abandoned at 1,290 ft. It was a wildcat test.

### Kent County

Caledonia Township (5n-10w)—Another peg in the defining of the Kent County oil field developed in the failure of the James J. McGerry, Inc.'s No. 1 George Welton, NW SW NW Section 36, abandoned as a dry hole at a depth of 2,016 ft.

Walker Township (6n-12w)—Smith Petroleum Co. and others' No. 10 William H. Gilbert estate, NE NW NE Section 10, was completed as a small producer, after-acid yield being 24 bbl. a day, completion depth being 1,773 ft.

Walker Township (7n-12w)—One of the seven Walker Township completions was a dry hole, the failure being Gordon Oil Co.'s No. 1 Thomas F. Molloy, SW NW SW Section 28, which was abandoned at 1,925 ft. Robert Alan Crude Oils' No. 1 H. G. Stanton and others, SE SE SE Section 19, was completed with trivial results, after-acid production being but 4 bbl. a day at 1,940 ft. Fisher & McCall Oil & Gas Co. and others' No. 1 Lincoln Lawns, SE SE SW Section 20, did 100 bbl. a day after acid, being completed at a depth of 1,904 ft. Louis Rose's No. 3 Linacre and others, SE SW SE Section 29, rated 200 bbl. after acid at 1,895 ft. Basin Oil Co. and others' No. 4 Wildeboer, NW NE NW Section 31, completed at 1,859 ft., had initial after-acid potential of 1,200 bbl. Two Smith Petroleum Co. completions also were recorded, No. 2 J. H. Cudahy and others, SE SE NW Section 33, having initial of 600 bbl. natural flow, at 1,847 ft., while No. 2 Grand Rapids Plaster Co., SE SE NW Section 34, completed at 1,940 ft., rated but 35 bbl. after acid treatment.

Wyoming Township (6n-12w)—Lamar Oil Co.'s No. 4 Grand Rapids Gravel Co., NE SE SW Section 4, completed at 1,793 ft., got after-acid potential of 700 bbl. a day, but production dropped rapidly after 2 days. Fisher & McCall Oil & Gas, Inc., and others' No. 1 John Klaver, C E½ NW NE Section 23, acidized, did 50 bbl. a day at 1,916 ft., while Clapsaddle, Harris & Fulton's No. 1 Louis Klammen, NE NW NW Section 24, was a dry hole, abandoned at 1,971 ft.

### Montcalm County

Home Township (12n-6w)—Belvidere Oil Co.'s No. 3 Charles Mann and others, C NE¼ Section 26, failed as a gas test, being abandoned at 1,316 ft.

### Ottawa County

Jamestown Township (5n-13w)—Dry at 1,712 ft., Vester Leonard Oil Co., Inc., abandoned No. 1 Margaret H. Strick, SW NW SE Section 29.

Tallmadge Township (7n-13w)—There were two completions each having after-acid initial of 960 bbl. a day. The wells are Edward B. Strom's No. 3 Park Association, SW SE NE Section 25, and Twin Drilling Co.'s No. 3 Park Association, SW NE NE Section 25.

### Tuscola County

Wisner Township (14n-7e)—Smith Petroleum Co.'s No. 1 Daniel McLaren, C E½ NW SE Section 22, was abandoned as a dry hole at 3,512 ft.

### Van Buren County

Bangor Township (2s-16w)—Bridger Basin Oil Corp.'s No. 4 Ulrath, SE NE NW Section 28, was abandoned at 1,006½ ft. as a dry hole.

Columbia Township (1s-15w)—R. H. Grant's No. 1 Charles Dean, NE SW SW Section 12, was dry and abandoned at 1,207 ft.

## Eastern Fields

*(Continued from Page 246)*

district; at 2,663 ft. in No. 4859 C. H. Sisson, Poca district, and at 1,418 ft. in No. 4861 C. C. Fisher.

In Poca district Alpha Gas Co. is drilling at 1,700 ft. in No. 2 J. W. Legg; West Virginia Gas Corp. drilling at 1,910 ft. on the P. B. Garnes land; Libby, Owens & Libby gas department at 4,515 ft. in No. 558 John P. Toney and others, in Washington district.

In Elk district Linden Drilling Co. is drilling at 100 ft. in the S. D. Robinson test. In Louden district Columbian Carbon Co. is down 1,860 ft. in No. 4 Campbells Creek Coal Co.

In Wood County United Carbon Co. is drilling at 1,200 ft. in the test on the J. K. Grimm and others farm, in Steel district.

# Summary of Operations in All Fields, October

## SUMMARY OF ALL FIELDS

| | Comp. | Prod. | Dry | Gas |
|---|---|---|---|---|
| Eastern fields | 434 | 1,230 | 29 | 71 |
| Lima | 1 | 0 | 1 | 0 |
| Central Ohio | 109 | 403 | 43 | 42 |
| Indiana | 46 | 4,308 | 15 | 5 |
| West. Kentucky | 51 | 737 | 25 | 3 |
| East. Kentucky | 20 | 25 | 2 | 17 |
| Michigan | 128 | 36,736 | 50 | 6 |
| Illinois | 374 | 74,263 | 76 | 3 |
| Kansas | 100 | 29,820 | 22 | 3 |
| Oklahoma | 119 | 14,059 | 46 | 5 |
| N. Cent. Texas | 244 | 79,492 | 80 | 7 |
| West Texas | 206 | 153,050 | 17 | 0 |
| Texas Panhandle | 49 | 14,122 | 2 | 10 |
| East Texas | 31 | 1,480 | 2 | 0 |
| East Cent. Texas | 24 | 2,270 | 13 | 3 |
| E. Texas border | 6 | 295 | 1 | 1 |
| Gulf Coast Texas | 103 | 24,414 | 16 | 4 |
| Southwest Texas | 179 | 14,163 | 59 | 11 |
| Arkansas | 18 | 6,430 | 9 | 0 |
| North Louisiana | 49 | 5,365 | 14 | 7 |
| Gulf Coast La. | 105 | 29,393 | 26 | 0 |
| Mississippi | 5 | 2,045 | 3 | 0 |
| Missouri | 10 | 0 | 7 | 3 |
| Montana | 11 | 465 | 3 | 2 |
| Wyoming | 10 | 2,845 | 3 | 1 |
| New Mexico | 61 | 28,001 | 3 | 1 |
| Colorado | 3 | 0 | 3 | 0 |
| Total Oct. | 2,496 | 525,411 | 570 | 205 |
| Total Sept. | 2,301 | 524,158 | 486 | 235 |
| Difference | 195 | 1,253 | 84 | 30 |

### Rigs and Wells Drilling

| | Rigs | Drlg. | Ttl. |
|---|---|---|---|
| Eastern fields | 76 | 416 | 492 |
| Lima | 1 | 9 | 10 |
| Central Ohio | 34 | 135 | 169 |
| Indiana | 8 | 73 | 81 |
| Western Kentucky | 2 | 79 | 81 |
| Eastern Kentucky | 10 | 25 | 35 |
| Michigan | 62 | 172 | 234 |
| Illinois | 57 | 395 | 452 |
| Kansas | 55 | 221 | 276 |
| Oklahoma | 37 | 316 | 353 |
| North Central Texas | 103 | 253 | 356 |
| West Texas | 45 | 268 | 313 |
| Texas Panhandle | 29 | 92 | 121 |
| East Texas | 16 | 19 | 35 |
| East Central Texas | 6 | 27 | 43 |
| East Texas border | 8 | 8 | 16 |
| Gulf Coast Texas | 20 | 125 | 145 |
| Southwest Texas | 30 | 195 | 225 |
| Arkansas | 27 | 26 | 53 |
| North Louisiana | 26 | 43 | 69 |
| Gulf Coast Louisiana | 23 | 124 | 147 |
| Mississippi | 6 | 12 | 18 |
| Missouri | 5 | 15 | 20 |
| Georgia | 1 | 0 | 1 |
| Montana | 1 | 47 | 48 |
| Wyoming | 6 | 63 | 69 |
| New Mexico | 24 | 138 | 162 |
| Utah | 1 | 4 | 5 |
| Colorado | 0 | 33 | 33 |
| Arizona | 0 | 8 | 8 |
| Iowa | 0 | 2 | 2 |
| Alabama | 0 | 5 | 5 |
| Nebraska | 2 | 7 | 9 |
| South Dakota | 0 | 1 | 1 |
| Total Oct. | 721 | 3,366 | 4,087 |
| Total Sept. | 639 | 3,170 | 3,809 |
| Difference | 82 | 196 | 278 |

## OKLAHOMA

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dlg. |
|---|---|---|---|---|---|---|
| Caddo | 8 | 4,093 | 2 | 0 | 3 | 17 |
| Canadian | 0 | 0 | 0 | 0 | 0 | 1 |
| Carter | 4 | 238 | 1 | 0 | 0 | 10 |
| Choctaw | 0 | 0 | 0 | 0 | 0 | 2 |
| Cleveland | 0 | 0 | 0 | 0 | 0 | 3 |
| Comanche | 0 | 0 | 0 | 0 | 0 | 5 |
| Cotton | 2 | 0 | 2 | 0 | 1 | 1 |
| Creek | 10 | 170 | 5 | 0 | 6 | 35 |
| Garfield | 1 | 75 | 0 | 0 | 0 | 3 |
| Garvin | 0 | 0 | 0 | 0 | 0 | 2 |
| Grady | 3 | 0 | 3 | 0 | 2 | 8 |
| Grant | 0 | 0 | 0 | 0 | 0 | 1 |
| Greer | 1 | 0 | 1 | 0 | 0 | 1 |
| Hughes | 5 | 831 | 1 | 2 | 1 | 4 |
| Jackson | 8 | 193 | 2 | 0 | 0 | 19 |
| Jefferson | 0 | 0 | 0 | 0 | 0 | 1 |
| Kay | 2 | 0 | 2 | 0 | 1 | 5 |
| Kingfisher | 0 | 0 | 0 | 0 | 0 | 1 |
| Kiowa | 2 | 0 | 2 | 0 | 0 | 5 |
| Lincoln | 3 | 128 | 1 | 0 | 2 | 6 |
| Logan | 2 | 75 | 1 | 0 | 0 | 4 |
| Love | 0 | 0 | 0 | 0 | 0 | 1 |
| Marshall | 0 | 0 | 0 | 0 | 0 | 3 |
| McIntosh | 2 | 0 | 1 | 1 | 0 | 1 |
| Noble | 1 | 0 | 1 | 0 | 0 | 4 |
| Okfuskee | 3 | 361 | 1 | 0 | 1 | 4 |
| Oklahoma | 1 | 7 | 0 | 0 | 1 | 4 |
| Osage | 7 | 38 | 4 | 0 | 4 | 14 |
| Pawnee | 4 | 71 | 1 | 0 | 1 | 10 |
| Payne | 4 | 237 | 1 | 1 | 0 | 10 |
| Pontotoc | 12 | 2,251 | 4 | 0 | 3 | 17 |
| Pottawatomie | 15 | 3,345 | 3 | 0 | 4 | 28 |
| Seminole | 11 | 1,926 | 3 | 0 | 1 | 18 |
| Stephens | 7 | 20 | 3 | 1 | 3 | 12 |
| Tillman | 1 | 0 | 1 | 0 | 0 | 3 |
| Tulsa | 0 | 0 | 0 | 0 | 1 | 10 |
| Wagoner | 0 | 0 | 0 | 0 | 0 | 9 |
| Washita | 0 | 0 | 0 | 0 | 0 | 1 |
| Eastern counties | 0 | 0 | 0 | 0 | 2 | 33 |
| Ttl. Oct. | 119 | 14.059 | 46 | 5 | 37 | 316 |
| Ttl. Sept. | 106 | 14,868 | 29 | 4 | 35 | 281 |
| Difference | 13 | 809 | 17 | 1 | 2 | 35 |

## KANSAS

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dlg. |
|---|---|---|---|---|---|---|
| Barber | 0 | 0 | 0 | 0 | 0 | 1 |
| Barton | 12 | 3,625 | 4 | 0 | 6 | 23 |
| Butler | 2 | 35 | 1 | 0 | 1 | 10 |
| Chase | 0 | 0 | 0 | 0 | 0 | 1 |
| Coffey | 1 | 0 | 1 | 0 | 1 | 1 |
| Cowley | 8 | 2,050 | 2 | 0 | 2 | 14 |
| Dickinson | 0 | 0 | 0 | 0 | 0 | 1 |
| Douglas | 0 | 0 | 0 | 0 | 0 | 1 |
| Ellis | 9 | 7,200 | 0 | 0 | 4 | 17 |
| Ellsworth | 2 | 771 | 0 | 0 | 3 | 2 |
| Franklin | 1 | 0 | 1 | 0 | 0 | 1 |
| Greenwood | 2 | 5 | 1 | 0 | 2 | 12 |
| Harvey | 1 | 444 | 0 | 0 | 0 | 4 |
| Jefferson | 0 | 0 | 0 | 0 | 0 | 2 |
| Johnson | 3 | 5 | 2 | 0 | 0 | 3 |
| Kingman | 1 | 0 | 0 | 1 | 0 | 2 |
| Lyon | 0 | 0 | 0 | 0 | 0 | 1 |
| Marion | 2 | 500 | 0 | 0 | 3 | 4 |
| McPherson | 5 | 787 | 1 | 0 | 4 | 11 |
| Ness | 0 | 0 | 0 | 0 | 0 | 1 |
| Osage | 0 | 0 | 0 | 0 | 0 | 1 |
| Pawnee | 0 | 0 | 0 | 0 | 0 | 1 |
| Pratt | 2 | 0 | 0 | 2 | 0 | 2 |
| Reno | 1 | 0 | 1 | 0 | 0 | 1 |
| Rice | 19 | 6,625 | 2 | 0 | 11 | 35 |
| Rooks | 2 | 329 | 0 | 0 | 1 | 6 |
| Rush | 0 | 0 | 0 | 0 | 0 | 1 |
| Russell | 21 | 6,157 | 3 | 0 | 14 | 44 |
| Sedgwick | 2 | 0 | 2 | 0 | 0 | 2 |
| Stafford | 2 | 1,191 | 0 | 0 | 2 | 9 |
| Sumner | 0 | 0 | 0 | 0 | 1 | 2 |
| Woodson | 2 | 96 | 1 | 0 | 0 | 3 |
| Wyandotte | 0 | 0 | 0 | 0 | 0 | 2 |
| Ttl. Oct. | 100 | 29,820 | 22 | 3 | 55 | 221 |
| Ttl. Sept. | 131 | 44,411 | 27 | 16 | 31 | 169 |
| Difference | 31 | 14,591 | 5 | 13 | 24 | 52 |

## WEST TEXAS

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dlg. |
|---|---|---|---|---|---|---|
| Andrews | 5 | 4,374 | 0 | 0 | 1 | 4 |
| Brewster | 0 | 0 | 0 | 0 | 0 | 1 |
| Cochran | 0 | 0 | 0 | 0 | 0 | 4 |
| Concho | 0 | 0 | 0 | 0 | 0 | 3 |
| Crane | 8 | 6,769 | 2 | 0 | 0 | 11 |
| Crockett | 6 | 325 | 0 | 0 | 0 | 5 |
| Crosby | 0 | 0 | 0 | 0 | 0 | 1 |
| Dawson | 0 | 0 | 0 | 0 | 0 | 1 |
| Ector | 54 | 57,698 | 1 | 0 | 12 | 57 |
| Gaines | 9 | 4,675 | 1 | 0 | 2 | 17 |
| Hockley | 3 | 2,317 | 0 | 0 | 0 | 9 |
| Howard | 11 | 2,855 | 5 | 0 | 0 | 4 |
| Hudspeth | 0 | 0 | 0 | 0 | 0 | 2 |
| Kent | 1 | 0 | 1 | 0 | 0 | 0 |
| Loving | 0 | 0 | 0 | 0 | 0 | 4 |
| Lynn | 0 | 0 | 0 | 0 | 0 | 1 |
| McCulloch | 0 | 0 | 0 | 0 | 0 | 1 |
| Nolan | 0 | 0 | 0 | 0 | 0 | 2 |
| Pecos | 21 | 4,939 | 2 | 0 | 8 | 24 |
| Reagan | 0 | 0 | 0 | 0 | 0 | 1 |
| Reeves | 1 | 0 | 1 | 0 | 0 | 1 |
| Runnels | 0 | 0 | 0 | 0 | 0 | 1 |
| Schleicher | 0 | 0 | 0 | 0 | 0 | 1 |
| Scurry | 5 | 813 | 0 | 0 | 2 | 9 |
| Sterling | 0 | 0 | 0 | 0 | 0 | 1 |
| Stonewall | 1 | 0 | 1 | 0 | 0 | 2 |
| Terrell | 0 | 0 | 0 | 0 | 0 | 3 |
| Tom Green. | 0 | 0 | 0 | 0 | 0 | 3 |
| Upton | 9 | 1,320 | 1 | 0 | 0 | 4 |
| Ward | 12 | 8,908 | 0 | 0 | 1 | 18 |
| Winkler | 8 | 1,243 | 1 | 0 | 3 | 11 |
| Yoakum | 52 | 56,814 | 1 | 0 | 16 | 62 |
| Ttl. Oct. | 206 | 153,050 | 17 | 0 | 45 | 268 |
| Ttl. Sept. | 179 | 114,652 | 11 | 0 | 61 | 268 |
| Difference | 27 | 38,398 | 6 | 0 | 16 | 0 |

## CENTRAL AND NORTH TEXAS

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dlg. |
|---|---|---|---|---|---|---|
| Archer | 32 | 18,046 | 7 | 0 | 26 | 38 |
| Brown | 10 | 257 | 8 | 0 | 0 | 7 |
| Baylor | 1 | 180 | 0 | 0 | 0 | 2 |
| Callahan | 9 | 68 | 5 | 0 | 1 | 4 |
| Clay | 10 | 5 | 9 | 0 | 7 | 6 |
| Coleman | 4 | 4 | 0 | 3 | 1 | 6 |
| Comanche | 10 | 206 | 3 | 0 | 1 | 4 |
| Cooke | 20 | 5,009 | 2 | 1 | 7 | 20 |
| Coryell | 0 | 0 | 0 | 0 | 1 | 1 |
| Denton | 0 | 0 | 0 | 0 | 0 | 2 |
| Erath | 0 | 0 | 0 | 0 | 0 | 4 |
| Eastland | 1 | 0 | 0 | 1 | 1 | 8 |
| Hamilton | 0 | 0 | 0 | 0 | 0 | 1 |
| Hardeman | 2 | 0 | 2 | 0 | 0 | 1 |
| Haskell | 1 | 0 | 1 | 0 | 0 | 1 |
| Hood | 0 | 0 | 0 | 0 | 0 | 1 |
| Jack | 11 | 2,616 | 7 | 0 | 4 | 9 |
| Johnson | 0 | 0 | 0 | 0 | 0 | 1 |
| Jones | 18 | 8,865 | 6 | 0 | 2 | 19 |
| Mills | 1 | 0 | 1 | 0 | 0 | 0 |
| Montague | 3 | 1,800 | 0 | 0 | 4 | 7 |
| Palo Pinto | 2 | 10 | 0 | 1 | 0 | 3 |
| Parker | 0 | 0 | 0 | 0 | 0 | 1 |
| Shackelford | 20 | 14,468 | 5 | 1 | 2 | 14 |
| Stephens | 2 | 2,168 | 0 | 0 | 0 | 6 |
| Tarrant | 0 | 0 | 0 | 0 | 1 | 1 |
| Taylor | 1 | 25 | 0 | 0 | 1 | 4 |
| Throckmorton | 0 | 0 | 0 | 0 | 0 | 1 |
| Wichita | 51 | 18,978 | 13 | 0 | 32 | 42 |
| Wilbarger | 8 | 3,081 | 3 | 0 | 2 | 11 |
| Wise | 0 | 0 | 0 | 0 | 0 | 5 |
| Young | 27 | 3,706 | 8 | 0 | 10 | 23 |
| Ttl. Oct. | 244 | 79.492 | 80 | 7 | 103 | 253 |
| Ttl. Sept. | 196 | 88,963 | 71 | 3 | 86 | 202 |
| Difference | 48 | 9,471 | 9 | 4 | 17 | 51 |

## EAST AND EAST CENTRAL TEXAS

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dlg. |
|---|---|---|---|---|---|---|
| Anderson | 2 | 103 | 0 | 1 | 1 | 9 |
| Angelina | 0 | 0 | 0 | 0 | 0 | 2 |
| Ellis | 1 | 0 | 1 | 0 | 0 | 0 |
| Falls | 0 | 0 | 0 | 0 | 0 | 1 |
| Fannin | 0 | 0 | 0 | 0 | 1 | 1 |
| Franklin | 2 | 773 | 0 | 0 | 2 | 1 |
| Freestone | 2 | 0 | 2 | 0 | 0 | 0 |
| Grayson | 1 | 0 | 1 | 0 | 0 | 2 |
| Gregg | 17 | 940 | 0 | 0 | 10 | 9 |
| Hill | 0 | 0 | 0 | 0 | 0 | 1 |
| Houston | 3 | 127 | 0 | 2 | 0 | 9 |
| Hunt | 2 | 0 | 2 | 0 | 0 | 2 |
| Leon | 1 | 0 | 1 | 0 | 0 | 1 |
| Limestone | 2 | 0 | 2 | 0 | 0 | 2 |
| Nacogdoches | 1 | 0 | 1 | 0 | 0 | 0 |
| Navarro | 3 | 355 | 2 | 0 | 1 | 3 |
| Red River | 0 | 0 | 0 | 0 | 0 | 2 |
| Rusk | 11 | 510 | 0 | 0 | 5 | 7 |
| Smith | 2 | 0 | 2 | 0 | 0 | 2 |
| Titus | 3 | 912 | 0 | 0 | 0 | 1 |
| Trinity | 0 | 0 | 0 | 0 | 1 | 0 |
| Upshur | 1 | 30 | 0 | 0 | 1 | 1 |
| Van Zandt | 1 | 0 | 1 | 0 | 0 | 0 |
| Ttl. Oct. | 55 | 3,750 | 15 | 3 | 22 | 56 |
| Ttl. Sept. | 45 | 2,988 | 11 | 3 | 20 | 44 |
| Difference | 10 | 762 | 4 | 0 | 2 | 12 |

## TEXAS PANHANDLE

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dlg. |
|---|---|---|---|---|---|---|
| Armstrong | 1 | 0 | 1 | 0 | 0 | 0 |
| Carson | 5 | 2,073 | 0 | 0 | 0 | 8 |
| Cottle | 0 | 0 | 0 | 0 | 0 | 1 |
| Deaf Smith | 0 | 0 | 0 | 0 | 0 | 1 |
| Dickens | 0 | 0 | 0 | 0 | 0 | 1 |
| Gray | 16 | 5,012 | 1 | 1 | 11 | 27 |
| Hartley | 0 | 0 | 0 | 0 | 0 | 1 |
| Hutchinson | 18 | 6,531 | 0 | 2 | 13 | 31 |
| Lipscomb | 0 | 0 | 0 | 0 | 0 | 1 |
| Moore | 5 | 0 | 0 | 5 | 1 | 9 |
| Motley | 0 | 0 | 0 | 0 | 1 | 0 |
| Ochiltree | 0 | 0 | 0 | 0 | 0 | 1 |
| Potter | 1 | 0 | 0 | 1 | 0 | 1 |
| Roberts | 0 | 0 | 0 | 0 | 0 | 1 |
| Sherman | 0 | 0 | 0 | 0 | 1 | 1 |
| Wheeler | 3 | 506 | 0 | 1 | 2 | 8 |
| Ttl. Oct. | 49 | 14,122 | 2 | 10 | 29 | 92 |
| Ttl. Sept. | 44 | 12,049 | 3 | 4 | 10 | 86 |
| Difference | 5 | 2,073 | 1 | 6 | 19 | 6 |

## SOUTHWEST TEXAS

| Field— | Comp. | Prod. | Dry | Gas | Rgs. | Dlg. |
|---|---|---|---|---|---|---|
| Adami | 1 | 35 | 0 | 0 | 0 | 2 |
| Agua Dulce | 3 | 0 | 1 | 2 | 0 | 4 |
| Alice | 4 | 50 | 3 | 0 | 0 | 3 |
| Alfred | 0 | 0 | 0 | 0 | 0 | 1 |
| Alta Vista | 0 | 0 | 0 | 0 | 0 | 1 |
| Angelita | 0 | 0 | 0 | 0 | 0 | 1 |
| Ben Bolt | 3 | 407 | 0 | 0 | 2 | 3 |
| Benavides | 1 | 0 | 0 | 1 | 0 | 3 |
| Bandera | 1 | 0 | 1 | 0 | 0 | 0 |
| Barbacoas | 0 | 0 | 0 | 0 | 0 | 1 |
| Bird Island | 0 | 0 | 0 | 0 | 0 | 1 |
| Byersville | 1 | 0 | 1 | 0 | 0 | 1 |
| Blas Uribe | 0 | 0 | 0 | 0 | 0 | 1 |
| Bruni | 0 | 0 | 0 | 0 | 0 | 1 |
| Buchanan | 0 | 0 | 0 | 0 | 0 | 1 |
| Campana | 1 | 0 | 1 | 0 | 0 | 0 |
| Carolina-Tex. | 1 | 0 | 0 | 1 | 0 | 0 |
| Cedro Hill | 0 | 0 | 0 | 0 | 0 | 1 |
| Chacon Lake | 1 | 2 | 0 | 0 | 1 | 0 |
| Callihan | 0 | 0 | 0 | 0 | 0 | 1 |
| Chiltipin | 1 | 0 | 0 | 1 | 1 | 0 |
| Clara Driscoll | 0 | 0 | 0 | 0 | 0 | 2 |
| Colorado | 4 | 380 | 0 | 0 | 0 | 2 |
| Cologne | 1 | 0 | 0 | 1 | 0 | 1 |
| Dale | 1 | 40 | 0 | 0 | 0 | 0 |
| Darst Creek | 5 | 619 | 0 | 0 | 1 | 4 |
| Driscoll | 3 | 618 | 0 | 0 | 0 | 1 |
| Dunlay | 1 | 0 | 1 | 0 | 0 | 1 |
| Escobas | 2 | 77 | 0 | 0 | 0 | 2 |
| E. White Pt. | 13 | 1,795 | 0 | 0 | 4 | 7 |
| East Placedo | 0 | 0 | 0 | 0 | 0 | 1 |
| Fitzsimmons | 2 | 120 | 0 | 0 | 0 | 2 |
| Fannin | 0 | 0 | 0 | 0 | 0 | 1 |
| Govt. Wells | 0 | 0 | 0 | 0 | 0 | 2 |
| Gas Ridge | 0 | 0 | 0 | 0 | 0 | 1 |
| Heyser | 2 | 277 | 0 | 0 | 0 | 2 |
| Hoffman | 7 | 374 | 0 | 0 | 1 | 4 |
| Ina | 1 | 25 | 0 | 0 | 0 | 1 |
| Kelsey | 4 | 351 | 0 | 0 | 0 | 2 |
| Keeran | 1 | 59 | 0 | 0 | 0 | 2 |
| Kimbro | 1 | 4 | 0 | 0 | 0 | 0 |
| La Coste | 0 | 0 | 0 | 0 | 0 | 1 |
| La Gloria | 0 | 0 | 0 | 0 | 0 | 4 |
| La Rosa | 3 | 292 | 0 | 1 | 0 | 3 |
| Lomo Novio. | 1 | 0 | 1 | 0 | 0 | 0 |
| Longhorn | 2 | 301 | 0 | 0 | 0 | 2 |
| Los Olmos | 0 | 0 | 0 | 0 | 0 | 1 |
| Luling | 1 | 4 | 0 | 0 | 1 | 0 |
| Luby | 2 | 192 | 0 | 0 | 1 | 1 |
| Lundell | 3 | 174 | 0 | 0 | 0 | 1 |
| Magnolia City | 0 | 0 | 0 | 0 | 0 | 1 |
| McCampbell | 7 | 825 | 0 | 0 | 1 | 6 |
| Margo | 0 | 0 | 0 | 0 | 0 | 1 |
| McFaddin | 1 | 145 | 0 | 0 | 0 | 1 |
| Mirando Valley | 7 | 213 | 3 | 0 | 0 | 5 |
| Minnie Bock. | 6 | 629 | 0 | 0 | 0 | 5 |
| Mtn. View | 0 | 0 | 0 | 0 | 0 | 2 |
| Oakville | 1 | 0 | 0 | 1 | 0 | 1 |
| Odem | 1 | 131 | 0 | 0 | 0 | 0 |
| Piedra De Lumbre | 3 | 1,045 | 0 | 0 | 0 | 2 |
| Piedra Pintas | 0 | 0 | 0 | 0 | 0 | 1 |
| Placedo | 0 | 0 | 0 | 0 | 0 | 1 |
| Plymouth | 1 | 168 | 0 | 0 | 0 | 3 |
| Rancho Solo. | 1 | 40 | 0 | 0 | 0 | 3 |
| Refugio | 0 | 0 | 0 | 0 | 0 | 1 |
| Reynolds | 6 | 843 | 0 | 1 | 2 | 5 |
| Ricaby | 0 | 0 | 0 | 0 | 0 | 2 |
| Richard King | 1 | 73 | 0 | 0 | 0 | 2 |
| Riverside | 0 | 0 | 0 | 0 | 0 | 1 |
| Rincon | 2 | 0 | 2 | 0 | 1 | 3 |
| S. R. C. | 2 | 87 | 0 | 0 | 0 | 1 |
| Salt Flat | 2 | 153 | 0 | 0 | 2 | 1 |
| Samfordyce | 2 | 10 | 1 | 0 | 0 | 3 |
| Saxet | 2 | 175 | 0 | 0 | 0 | 1 |
| Sejita | 1 | 0 | 0 | 1 | 0 | 0 |
| Seven Sisters | 2 | 200 | 0 | 1 | 0 | 2 |
| Southland | 1 | 0 | 1 | 0 | 0 | 1 |
| South Clara Driscoll | 2 | 325 | 0 | 0 | 0 | 2 |
| S. Ricaby | 2 | 75 | 1 | 0 | 1 | 0 |
| Stratton | 0 | 0 | 0 | 0 | 0 | 1 |
| Sun | 0 | 0 | 0 | 0 | 1 | 1 |
| Tomoconnor. | 3 | 2,590 | 0 | 0 | 0 | 2 |
| Victoria | 1 | 0 | 1 | 0 | 0 | 1 |
| Volpe | 0 | 0 | 0 | 0 | 1 | 0 |
| Wade City | 0 | 0 | 0 | 0 | 0 | 1 |
| Walnut Crk. | 1 | 0 | 1 | 0 | 0 | 0 |
| W. Cole | 1 | 40 | 0 | 0 | 0 | 1 |
| W. Saxet | 0 | 0 | 0 | 0 | 0 | 1 |
| White Creek. | 2 | 200 | 0 | 0 | 0 | 0 |
| Zoboroski | 1 | 0 | 1 | 0 | 0 | 0 |
| Miscellaneous | 39 | 0 | 39 | 0 | 9 | 56 |
| Ttl. Oct. | 179 | 14,163 | 59 | 11 | 30 | 195 |
| Ttl. Sept. | 165 | 12,262 | 42 | 16 | 35 | 164 |
| Difference | 14 | 1,901 | 17 | 5 | 5 | 31 |

## TEXAS GULF COAST

| Field— | Comp. | Prod. | Dry | Gas | Rgs. | Dlg. |
|---|---|---|---|---|---|---|
| Ace | 1 | 240 | 0 | 0 | 0 | 0 |
| Aldine | 1 | 0 | 1 | 0 | 0 | 0 |
| Allen | 0 | 0 | 0 | 0 | 0 | 1 |
| Anahuac | 3 | 1,193 | 0 | 0 | 0 | 2 |
| Anchor | 1 | 267 | 0 | 0 | 0 | 2 |
| Bammel | 1 | 0 | 0 | 1 | 0 | 1 |
| Barbers Hill. | 0 | 0 | 0 | 0 | 0 | 1 |
| Big Creek | 0 | 0 | 0 | 0 | 0 | 1 |
| Blue Ridge | 0 | 0 | 0 | 0 | 0 | 1 |
| Boling | 1 | 43 | 0 | 0 | 0 | 0 |
| Caplen | 0 | 0 | 0 | 0 | 0 | 1 |
| Cedar Point | 1 | 0 | 0 | 0 | 0 | 1 |
| Chocolate Bayou | 0 | 0 | 0 | 0 | 0 | 2 |
| Clam Lake | 0 | 0 | 0 | 0 | 1 | 0 |
| Clear Lake | 5 | 519 | 0 | 1 | 0 | 2 |
| Clinton | 0 | 0 | 0 | 0 | 1 | 0 |
| Conroe | 1 | 0 | 1 | 0 | 0 | 0 |
| Cotton Lake. | 1 | 150 | 0 | 0 | 0 | 0 |
| Cordele | 2 | 310 | 0 | 0 | 0 | 1 |
| Dickinson | 1 | 72 | 0 | 0 | 1 | 2 |
| Esperson | 2 | 1,137 | 0 | 0 | 0 | 2 |
| Fannett | 0 | 0 | 0 | 0 | 0 | 1 |
| Fairbanks | 1 | 153 | 0 | 0 | 0 | 3 |
| Francitas | 1 | 140 | 0 | 0 | 0 | 1 |
| Friendswood | 9 | 4,505 | 0 | 0 | 1 | 2 |
| Garwood | 0 | 0 | 0 | 0 | 0 | 1 |
| Hardin | 3 | 610 | 0 | 0 | 0 | 3 |
| Hastings | 4 | 1,610 | 1 | 0 | 0 | 7 |
| High Island | 0 | 0 | 0 | 0 | 0 | 1 |
| Hull | 1 | 148 | 0 | 0 | 0 | 1 |
| Humble | 3 | 32 | 2 | 0 | 0 | 1 |
| League City | 0 | 0 | 0 | 0 | 0 | 5 |
| Liberty | 0 | 0 | 0 | 0 | 0 | 1 |
| Louise | 1 | 0 | 1 | 0 | 0 | 1 |
| Lovells Lake | 6 | 855 | 1 | 0 | 1 | 5 |
| Labelle | 0 | 0 | 0 | 0 | 0 | 1 |
| Manvel | 1 | 315 | 0 | 0 | 0 | 1 |
| Martha | 1 | 311 | 0 | 0 | 0 | 3 |
| Markham | 1 | 0 | 1 | 0 | 0 | 0 |
| Magnet | 2 | 801 | 0 | 0 | 1 | 0 |
| Mauritz | 0 | 0 | 0 | 0 | 0 | 1 |
| Old Ocean | 3 | 885 | 0 | 0 | 2 | 4 |
| Orange | 0 | 0 | 0 | 0 | 0 | 3 |
| Orchard | 0 | 0 | 0 | 0 | 0 | 1 |
| Pierce Jctn. | 0 | 0 | 0 | 0 | 1 | 2 |
| Pickett Ridg. | 1 | 90 | 0 | 0 | 0 | 0 |
| Pt. Neches | 1 | 0 | 0 | 1 | 0 | 1 |
| Saratoga | 1 | 14 | 0 | 0 | 0 | 0 |
| Segno | 4 | 1,566 | 0 | 0 | 0 | 5 |
| Silsbee | 1 | 305 | 0 | 0 | 0 | 1 |
| Sour Lake | 1 | 150 | 0 | 0 | 0 | 0 |
| S. China | 1 | 190 | 0 | 0 | 1 | 0 |
| S. Cotton Lake | 3 | 399 | 0 | 0 | 0 | 4 |
| S. Houston | 0 | 0 | 0 | 0 | 0 | 1 |
| Spanish Camp | 0 | 0 | 0 | 0 | 0 | 1 |
| Spindletop | 1 | 0 | 1 | 0 | 0 | 1 |
| Spurger | 2 | 730 | 0 | 0 | 0 | 2 |
| Thompson | 5 | 2,903 | 0 | 0 | 1 | 4 |
| Texana | 0 | 0 | 0 | 0 | 0 | 1 |
| Tomball | 3 | 961 | 0 | 0 | 1 | 1 |
| Turtle Bay | 1 | 30 | 0 | 0 | 0 | 2 |
| Van Vleck | 0 | 0 | 0 | 0 | 0 | 1 |
| W. Beaumont | 0 | 0 | 0 | 0 | 0 | 1 |
| W. Ranch | 5 | 1,939 | 0 | 0 | 0 | 7 |
| W. Columbia | 2 | 423 | 0 | 0 | 0 | 2 |
| Withers | 6 | 418 | 0 | 1 | 2 | 4 |
| Miscellaneous | 7 | 0 | 7 | 0 | 6 | 17 |
| Ttl. Oct. | 103 | 24.414 | 16 | 4 | 20 | 125 |
| Ttl. Sept. | 128 | 25,435 | 25 | 9 | 24 | 102 |
| Difference | 25 | 1,021 | 9 | 5 | 4 | 23 |

## COASTAL LOUISIANA

| Field— | Comp. | Prod. | Dry | Gas | Rgs. | Dlg. |
|---|---|---|---|---|---|---|
| Abbeville | 1 | 24 | 0 | 0 | 0 | 2 |
| Bancroft | 3 | 576 | 1 | 0 | 1 | 2 |
| Bateman Lake | 1 | 271 | 0 | 0 | 0 | 1 |
| Bay St. Elaine | 0 | 0 | 0 | 0 | 0 | 2 |
| Black Bayou. | 1 | 0 | 1 | 0 | 0 | 0 |
| Bayou des Glaize | 0 | 0 | 0 | 0 | 1 | 0 |
| Caillou Is. | 1 | 0 | 1 | 0 | 0 | 2 |
| Cameron Meadow | 0 | 0 | 0 | 0 | 0 | 1 |
| Chalkley | 2 | 453 | 1 | 0 | 0 | 2 |
| Creole | 1 | 389 | 0 | 0 | 0 | 1 |
| Chacahoula | 1 | 453 | 0 | 0 | 1 | 1 |
| Charenton | 16 | 2,899 | 1 | 0 | 3 | 3 |
| Cheneyville | 3 | 1,000 | 0 | 0 | 0 | 3 |
| Choctaw | 1 | 275 | 0 | 0 | 1 | 0 |
| Darrow | 1 | 682 | 0 | 0 | 0 | 1 |
| Dog Lake | 0 | 0 | 0 | 0 | 0 | 1 |
| E Baton Rouge | 10 | 2,582 | 1 | 0 | 1 | 4 |
| Eola | 7 | 2,964 | 1 | 0 | 2 | 5 |
| Fausse Point | 0 | 0 | 0 | 0 | 0 | 1 |
| Garden Is. | 1 | 140 | 0 | 0 | 0 | 2 |
| Golden Meadow | 15 | 7,797 | 1 | 0 | 4 | 13 |
| Grand Bay | 1 | 768 | 0 | 0 | 1 | 2 |
| Grand Lake | 2 | 360 | 1 | 0 | 0 | 1 |
| Hackberry | 3 | 236 | 2 | 0 | 1 | 3 |

| Horseshoe | | | | | | |
|---|---|---|---|---|---|---|
| Bayou | 0 | 0 | 0 | 0 | 0 | 1 |
| Iowa | 0 | 0 | 0 | 0 | 0 | 1 |
| Jeanerette | 0 | 0 | 0 | 0 | 0 | 1 |
| Jefferson Is. | 0 | 0 | 0 | 0 | 0 | 1 |
| Jennings | 1 | 428 | 0 | 0 | 0 | 3 |
| Lafitte | 1 | 1,189 | 0 | 0 | 0 | 2 |
| Lake Long | 1 | 48 | 0 | 0 | 0 | 1 |
| Lake Hermitage | 0 | 0 | 0 | 0 | 0 | 1 |
| Lake Mongoulois | 0 | 0 | 0 | 0 | 0 | 1 |
| La Pice | 0 | 0 | 0 | 0 | 0 | 2 |
| Lake Pelto | 1 | 580 | 0 | 0 | 0 | 1 |
| Leesville | 0 | 0 | 0 | 0 | 0 | 1 |
| N. Crowley | 1 | 408 | 0 | 0 | 1 | 1 |
| N. Elton | 0 | 0 | 0 | 0 | 0 | 1 |
| New Iberia | 2 | 813 | 0 | 0 | 1 | 5 |
| Paradis | 0 | 0 | 0 | 0 | 0 | 1 |
| Perkins | 1 | 0 | 1 | 0 | 0 | 0 |
| Port Barre | 1 | 211 | 0 | 0 | 1 | 2 |
| Potash | 0 | 0 | 0 | 0 | 0 | 1 |
| Quarantine Bay | 3 | 2,059 | 0 | 0 | 0 | 2 |
| S. Houma | 0 | 0 | 0 | 0 | 0 | 1 |
| S. Roanoke | 1 | 0 | 1 | 0 | 0 | 0 |
| Sorrento | 0 | 0 | 0 | 0 | 0 | 1 |
| Sulphur | 1 | 0 | 1 | 0 | 0 | 2 |
| Valentine | 2 | 550 | 1 | 0 | 0 | 2 |
| Venice | 0 | 0 | 0 | 0 | 0 | 1 |
| Villa Platte | 5 | 1,069 | 0 | 0 | 2 | 5 |
| W. Gueydan | 1 | 100 | 0 | 0 | 0 | 1 |
| West Lake Verret | 0 | 0 | 0 | 0 | 0 | 1 |
| White Castle | 0 | 0 | 0 | 0 | 0 | 1 |
| Woodlawn | 1 | 69 | 0 | 0 | 0 | 4 |
| Miscellaneous | 11 | 0 | 11 | 0 | 2 | 23 |
| Ttl. Oct. | 105 | 29,393 | 26 | 0 | 23 | 124 |
| Ttl. Sept. | 80 | 17,155 | 17 | 1 | 15 | 127 |
| Difference | 25 | 12,238 | 9 | 1 | 8 | 3 |

## EAST TEXAS BORDER

| County— | Comp. | Prod. | Dry | Gas | *Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Cass | 1 | 0 | 0 | 1 | 0 | 0 |
| Harrison | 0 | 0 | 0 | 0 | 1 | 0 |
| Marion-Rodessa | 1 | 235 | 0 | 0 | 1 | 5 |
| Marion-Other | 3 | 60 | 0 | 0 | 5 | 2 |
| Panola | 1 | 0 | 1 | 0 | 0 | 0 |
| Shelby | 0 | 0 | 0 | 0 | 1 | 1 |
| Ttl. Oct. | 6 | 295 | 1 | 1 | 8 | 8 |
| Ttl. Sept. | 7 | 850 | 2 | 2 | 7 | 7 |
| Difference | 1 | 555 | 1 | 1 | 1 | 1 |

*Gas production: Cass County, 20,000,000 cu. ft.

## MISSOURI

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Adair | 1 | 0 | 1 | 0 | 1 | 2 |
| Andrew | 0 | 0 | 0 | 0 | 0 | 1 |
| Bates | 0 | 0 | 0 | 0 | 0 | 1 |
| Bollinger | 0 | 0 | 0 | 0 | 0 | 1 |
| Buchanan | 0 | 0 | 0 | 0 | 0 | 1 |
| Carroll | 0 | 0 | 0 | 0 | 1 | 0 |
| Clay | 1 | 0 | 0 | 1 | 0 | 1 |
| Clinton | 0 | 0 | 0 | 0 | 0 | 1 |
| Daviess | 0 | 0 | 0 | 0 | 0 | 1 |
| DeKalb | 0 | 0 | 0 | 0 | 0 | 1 |
| Harrison | 1 | 0 | 1 | 0 | 0 | 0 |
| Holt | 0 | 0 | 0 | 0 | 0 | 1 |
| Jackson | 1 | 0 | 1 | 0 | 0 | 1 |
| Knox | 0 | 0 | 0 | 0 | 1 | 0 |
| Livingston | 1 | 0 | 1 | 0 | 0 | 0 |
| Mercer | 0 | 0 | 0 | 0 | 0 | 1 |
| Platte | 3 | 0 | 1 | 2 | 1 | 0 |
| Ray | 0 | 0 | 0 | 0 | 0 | 1 |
| Schuyler | 1 | 0 | 1 | 0 | 1 | 0 |
| Shelby | 1 | 0 | 1 | 0 | 0 | 0 |
| St. Charles | 0 | 0 | 0 | 0 | 0 | 1 |
| Ttl. Oct. | 10 | 0 | 7 | 3 | 5 | 15 |
| Ttl. Sept. | 8 | 0 | 5 | 3 | 1 | 21 |
| Difference | 2 | 0 | 2 | 0 | 4 | 6 |

## NORTH LOUISIANA

| Parish— | Comp. | Prod. | Dry | Gas | *Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Bossier | 2 | 10 | 1 | 0 | 2 | 2 |
| Caddo-Rodessa | 2 | 425 | 0 | 0 | 0 | 1 |
| Caddo-Other | 24 | 2,535 | 7 | 0 | 7 | 14 |
| Caldwell | 1 | 0 | 1 | 0 | 0 | 1 |
| Catahoula | 0 | 0 | 0 | 0 | 1 | 0 |
| Claiborne | 1 | 5 | 0 | 0 | 0 | 2 |
| De Soto | 0 | 0 | 0 | 0 | 5 | 1 |
| Franklin | 0 | 0 | 0 | 0 | 0 | 1 |
| Grant | 1 | 5 | 0 | 0 | 0 | 0 |
| La Salle | 4 | 0 | 4 | 0 | 0 | 1 |
| Morehouse | 2 | 0 | 0 | 2 | 0 | 2 |
| Natchitoches | 0 | 0 | 0 | 0 | 2 | 0 |
| Sabine | 3 | 105 | 1 | 0 | 4 | 7 |
| Tensas | 0 | 0 | 0 | 0 | 1 | 0 |
| Union | 5 | 0 | 0 | 5 | 2 | 5 |
| Webster | 4 | 2,280 | 0 | 0 | 2 | 6 |
| Ttl. Oct. | 49 | 5,365 | 14 | 7 | 26 | 43 |
| Ttl. Sept. | 42 | 3,210 | 13 | 11 | 21 | 42 |
| Difference | 7 | 2,155 | 1 | 4 | 5 | 1 |

*Gas production: Morehouse Parish, 6,000,000 cu. ft.; Union Parish, 8,000,000 cu. ft.

## ARKANSAS

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Clark | 0 | 0 | 0 | 0 | 3 | 0 |
| Clay | 0 | 0 | 0 | 0 | 1 | 0 |
| Columbia | 6 | 2,850 | 1 | 0 | 3 | 17 |
| Craighead | 0 | 0 | 0 | 0 | 1 | 0 |
| Faulkner | 0 | 0 | 0 | 0 | 1 | 0 |
| Hot Springs | 0 | 0 | 0 | 0 | 1 | 0 |
| Howard | 0 | 0 | 0 | 0 | 2 | 0 |
| Independence | 0 | 0 | 0 | 0 | 0 | 1 |
| Lafayette | 2 | 2,380 | 0 | 0 | 0 | 2 |
| Little River | 0 | 0 | 0 | 0 | 1 | 0 |
| Lonoke | 2 | 0 | 2 | 0 | 3 | 0 |
| Miller-Rodessa | 1 | 450 | 0 | 0 | 1 | 0 |
| Nevada | 1 | 0 | 1 | 0 | 2 | 0 |
| Ouachita | 1 | 0 | 1 | 0 | 2 | 1 |
| Pulaski | 0 | 0 | 0 | 0 | 1 | 0 |
| Saline | 0 | 0 | 0 | 0 | 1 | 0 |
| Sevier | 0 | 0 | 0 | 0 | 1 | 0 |
| Union | 5 | 770 | 4 | 0 | 2 | 5 |
| White | 0 | 0 | 0 | 0 | 1 | 0 |
| Ttl. Oct. | 18 | 6,430 | 9 | 0 | 27 | 28 |
| Ttl. Sept. | 21 | 7,235 | 4 | 1 | 22 | 27 |
| Difference | 3 | 805 | 5 | 1 | 5 | 1 |

## MISSISSIPPI

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Copiah | 0 | 0 | 0 | 0 | 0 | 1 |
| Harrison | 0 | 0 | 0 | 0 | 0 | 1 |
| Hinds | 2 | 0 | 2 | 0 | 1 | 2 |
| Issequena | 0 | 0 | 0 | 0 | 0 | 1 |
| Itawamba | 0 | 0 | 0 | 0 | 1 | 0 |
| Kemper | 0 | 0 | 0 | 0 | 0 | 1 |
| Lafayette | 1′ | 0 | 1 | 0 | 0 | 0 |
| Lamar | 0 | 0 | 0 | 0 | 0 | 1 |
| Pike | 0 | 0 | 0 | 0 | 0 | 1 |
| Prentiss | 0 | 0 | 0 | 0 | 1 | 0 |
| Simpson | 0 | 0 | 0 | 0 | 0 | 1 |
| Wilkinson | 0 | 0 | 0 | 0 | 0 | 1 |
| Yazoo | 2 | 2,045 | 0 | 0 | 3 | 2 |
| Ttl. Oct. | 5 | 2,045 | 3 | 0 | 6 | 12 |
| Ttl. Sept. | 1 | 185 | 0 | 0 | 5 | 10 |
| Difference | 4 | 1,860 | 3 | 0 | 1 | 2 |

## ALABAMA

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Barbour | 0 | 0 | 0 | 0 | 0 | 1 |
| Choctaw | 0 | 0 | 0 | 0 | 0 | 1 |
| Houston | 0 | 0 | 0 | 0 | 0 | 1 |
| Lawrence | 0 | 0 | 0 | 0 | 0 | 1 |
| Washington | 0 | 0 | 0 | 0 | 0 | 1 |
| Ttl. Oct. | 0 | 0 | 0 | 0 | 0 | 5 |

## ROCKY MOUNTAIN AREA

### New Mexico

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Chaves | 0 | 0 | 0 | 0 | 1 | 7 |
| Dona Ana | 0 | 0 | 0 | 0 | 0 | 2 |
| Eddy | 28 | 13,614 | 2 | 0 | 8 | 57 |
| Grant | 0 | 0 | 0 | 0 | 0 | 1 |
| Lea | 30 | 14,067 | 0 | 1 | 14 | 53 |
| Luna | 0 | 0 | 0 | 0 | 0 | 1 |
| Otero | 0 | 0 | 0 | 0 | 0 | 2 |
| Bernalillo | 0 | 0 | 0 | 0 | 0 | 2 |
| McKinley | 0 | 0 | 0 | 0 | 0 | 1 |
| San Juan | 3 | 320 | 1 | 0 | 1 | 6 |
| San Miguel | 0 | 0 | 0 | 0 | 0 | 2 |
| Socorro | 0 | 0 | 0 | 0 | 0 | 1 |
| Torrance | 0 | 0 | 0 | 0 | 0 | 1 |
| Valencia | 0 | 0 | 0 | 0 | 0 | 2 |
| Ttl. Oct. | 61 | 28,001 | 3 | 1 | 24 | 138 |
| Ttl. Sept. | 43 | 17,734 | 4 | 2 | 17 | 144 |
| Difference | 18 | 10,267 | 1 | 1 | 7 | 6 |

### Colorado

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Adams | 0 | 0 | 0 | 0 | 0 | 1 |
| Archuleta | 0 | 0 | 0 | 0 | 0 | 2 |
| Boulder | 0 | 0 | 0 | 0 | 0 | 3 |
| Fremont | 0 | 0 | 0 | 0 | 0 | 2 |
| Huerfano | 3 | 0 | 3 | 0 | 0 | 5 |
| La Plata | 0 | 0 | 0 | 0 | 0 | 1 |
| Las Animas | 0 | 0 | 0 | 0 | 0 | 1 |
| Moffat | 0 | 0 | 0 | 0 | 0 | 3 |
| Park | 0 | 0 | 0 | 0 | 0 | 1 |
| Pueblo | 0 | 0 | 0 | 0 | 0 | 2 |
| Rio Blanco | 0 | 0 | 0 | 0 | 0 | 3 |
| Routt | 0 | 0 | 0 | 0 | 0 | 2 |
| Miscellaneous | 0 | 0 | 0 | 0 | 0 | 7 |
| Total Oct.. | 3 | 0 | 3 | 0 | 0 | *33 |
| Total Sept. | 2 | 130 | 0 | 0 | 2 | 40 |
| Difference | 1 | 130 | 3 | 0 | 2 | 7 |

*Eight idle wells suspended.

### Wyoming

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Albany | 1 | 0 | 1 | 0 | 0 | 0 |
| Big Horn | 0 | 0 | 0 | 0 | 0 | 3 |
| Carbon | 0 | 0 | 0 | 0 | 0 | 5 |
| Converse | 0 | 0 | 0 | 0 | 0 | 5 |
| Fremont | 0 | 0 | 0 | 0 | 0 | 3 |
| Hot Springs | 0 | 0 | 0 | 0 | 0 | 2 |
| Natrona | 0 | 0 | 0 | 0 | 0 | 3 |
| Niobrara | 2 | 2,564 | 0 | 0 | 4 | 17 |
| Park | 1 | 0 | 0 | 1 | 0 | 3 |
| Sublette | 1 | 28 | 0 | 0 | 0 | 5 |
| Sweetwater | 1 | 210 | 0 | 0 | 1 | 4 |
| Uinta | 0 | 0 | 0 | 0 | 0 | 4 |
| Weston | 4 | 43 | 2 | 0 | 1 | 6 |
| Miscellaneous | 0 | 0 | 0 | 0 | 0 | 3 |
| Total Oct.. | 10 | 2,845 | 3 | 1 | 6 | *63 |
| Total. Sept. | 19 | 13,459 | 7 | 1 | 3 | 73 |
| Difference | 9 | 10,614 | 4 | 0 | 3 | 10 |

*Thirteen idle wells suspended.

### Utah

| | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Total Oct | 0 | 0 | 0 | 0 | 1 | 4 |
| Total Sept. | 0 | 0 | 0 | 0 | 1 | 4 |
| Difference | 0 | 0 | 0 | 0 | 0 | 0 |

### Montana

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Blaine | 0 | 0 | 0 | 0 | 0 | 2 |
| Carbon | 1 | 0 | 1 | 0 | 0 | 5 |
| Fergus | 0 | 0 | 0 | 0 | 0 | 1 |
| Glacier | 4 | 385 | 1 | 0 | 1 | 11 |
| Liberty | 0 | 0 | 0 | 0 | 0 | 1 |
| Meagher | 1 | 0 | 1 | 0 | 0 | 0 |
| Petroleum | 0 | 0 | 0 | 0 | 0 | 2 |
| Pondera | 0 | 0 | 0 | 0 | 0 | 1 |
| Teton | 1 | 0 | 0 | 1 | 0 | 0 |
| Toole | 4 | 80 | 0 | 1 | 0 | 17 |
| Miscellaneous | 0 | 0 | 0 | 0 | 0 | 7 |
| Total Oct.. | 11 | 465 | 3 | 2 | 1 | *47 |
| Total Sept. | 10 | 281 | 2 | 1 | 0 | 46 |
| Difference | 1 | 184 | 1 | 1 | 1 | 1 |

*Six idle wells suspended.

## EASTERN KENTUCKY

| County— | Comp. | Prod. | Dry | Gas | *Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Knott | 3 | 0 | 0 | 3 | 0 | 4 |
| Magoffin | 0 | 0 | 0 | 0 | 1 | 2 |
| Martin | 4 | 25 | 0 | 3 | 2 | 4 |
| Floyd | 6 | 0 | 1 | 5 | 0 | 4 |
| Powell | 0 | 0 | 0 | 0 | 5 | 8 |
| Lawrence | 0 | 0 | 0 | 0 | 1 | 0 |
| Pike | 7 | 0 | 1 | 6 | 1 | 0 |
| Wolfe | 0 | 0 | 0 | 0 | 0 | 1 |
| Knox | 0 | 0 | 0 | 0 | 0 | 1 |
| Lee | 0 | 0 | 0 | 0 | 0 | 1 |
| Ttl. Oct. | 20 | 25 | 2 | 17 | 10 | 25 |
| Ttl. Sept. | 24 | 79 | 2 | 18 | 11 | 38 |
| Difference | 4 | 54 | 0 | 1 | 1 | 13 |

*Total production for gas wells listed, 5,778,000 cu. ft. per day.

## WESTERN KENTUCKY

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Breckinridge | 4 | 10 | 3 | 0 | 0 | 2 |
| Butler | 3 | 24 | 1 | 0 | 0 | 5 |
| Caldwell | 0 | 0 | 0 | 0 | 0 | 1 |
| Christian | 0 | 0 | 0 | 0 | 0 | 2 |
| Daviess | 16 | 357 | 7 | 1 | 0 | 31 |
| Hancock | 7 | 15 | 5 | 1 | 0 | 8 |
| Henderson | 3 | 170 | 1 | 0 | 1 | 3 |
| Hopkins | 0 | 0 | 0 | 0 | 0 | 2 |
| Livingston | 0 | 0 | 0 | 0 | 0 | 3 |
| Logan | 0 | 0 | 0 | 0 | 0 | 2 |
| McLean | 3 | 62 | 1 | 0 | 0 | 2 |
| Meade | 0 | 0 | 0 | 0 | 0 | 1 |
| Ohio | 12 | 99 | 4 | 1 | 1 | 14 |
| Todd | 0 | 0 | 0 | 0 | 0 | 2 |
| Union | 1 | 0 | 1 | 0 | 0 | 0 |
| Webster | 2 | 0 | 2 | 0 | 0 | 1 |
| Ttl. Oct. | 51 | 737 | 25 | 3 | 2 | 79 |
| Ttl. Sept. | 33 | 821 | 17 | 1 | 0 | 67 |
| Difference | 18 | 84 | 8 | 2 | 2 | 12 |

## ILLINOIS

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Adams | 0 | 0 | 0 | 0 | 0 | 1 |
| Bond | 2 | 0 | 2 | 0 | 0 | 4 |
| Brown | 0 | 0 | 0 | 0 | 0 | 3 |
| Clark | 3 | 0 | 3 | 0 | 0 | 4 |
| Clay | 21 | 4,783 | 4 | 0 | 0 | 13 |
| Clinton | 3 | 0 | 3 | 0 | 1 | 5 |
| Coles | 0 | 0 | 0 | 0 | 0 | 3 |
| Cook | 0 | 0 | 0 | 0 | 0 | 1 |
| Cumberland | 0 | 0 | 0 | 0 | 0 | 4 |
| Edgar | 0 | 0 | 0 | 0 | 1 | 3 |
| Edwards | 12 | 760 | 7 | 0 | 0 | 8 |
| Effingham | 3 | 0 | 3 | 0 | 0 | 1 |
| Fayette | 96 | 27,472 | 5 | 0 | 10 | 54 |
| Ford | 0 | 0 | 0 | 0 | 0 | 1 |
| Franklin | 2 | 0 | 2 | 0 | 0 | 1 |
| Gallatin | 0 | 0 | 0 | 0 | 1 | 0 |
| Greene | 0 | 0 | 0 | 0 | 0 | 2 |
| Hamilton | 2 | 400 | 1 | 0 | 1 | 3 |
| Henderson | 0 | 0 | 0 | 0 | 0 | 1 |
| Jackson | 0 | 0 | 0 | 0 | 0 | 1 |
| Jasper | 0 | 0 | 0 | 0 | 0 | 1 |
| Jefferson | 6 | 753 | 1 | 0 | 1 | 8 |
| Jersey | 0 | 0 | 0 | 0 | 0 | 2 |
| Johnson | 0 | 0 | 0 | 0 | 0 | 2 |
| Lawrence | 6 | 3 | 2 | 3 | 1 | 7 |
| Livingston | 0 | 0 | 0 | 0 | 0 | 1 |
| Madison | 0 | 0 | 0 | 0 | 0 | 2 |
| Marion | 90 | 25,988 | 13 | 0 | 5 | 109 |
| Massac | 0 | 0 | 0 | 0 | 0 | 2 |
| McDonough | 2 | 0 | 2 | 0 | 0 | 1 |
| Menard | 0 | 0 | 0 | 0 | 0 | 1 |
| Monroe | 0 | 0 | 0 | 0 | 1 | 5 |
| Montgomery | 1 | 0 | 1 | 0 | 0 | 1 |
| Perry | 3 | 0 | 3 | 0 | 0 | 2 |
| Pike | 0 | 0 | 0 | 0 | 0 | 1 |
| Pope | 0 | 0 | 0 | 0 | 0 | 1 |
| Randolph | 0 | 0 | 0 | 0 | 0 | 3 |
| Richland | 8 | 1,428 | 1 | 0 | 3 | 12 |
| Schuyler | 0 | 0 | 0 | 0 | 0 | 1 |
| Shelby | 0 | 0 | 0 | 0 | 0 | 2 |
| St. Clair | 5 | 40 | 3 | 0 | 1 | 7 |
| Tazewell | 0 | 0 | 0 | 0 | 0 | 1 |
| Wabash | 68 | 8,508 | 11 | 0 | 9 | 44 |
| Washington | 15 | 753 | 4 | 0 | 4 | 10 |
| Wayne | 12 | 1,594 | 1 | 0 | 7 | 26 |
| White | 14 | 1,781 | 4 | 0 | 9 | 26 |
| Williamson | 0 | 0 | 0 | 0 | 1 | 2 |
| Fulton | 0 | 0 | 0 | 0 | 0 | 1 |
| Peoria | 0 | 0 | 0 | 0 | 0 | 1 |
| Saline | 0 | 0 | 0 | 0 | 1 | 0 |
| Ttl. Oct. | 374 | 74,263 | 76 | 3 | 57 | 395 |
| Ttl. Sept. | 314 | 75,046 | 54 | 2 | 78 | 377 |
| Difference | 60 | 783 | 22 | 1 | 21 | 18 |

## INDIANA

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Blackford | 0 | 0 | 0 | 0 | 0 | 1 |
| Daviess | 1 | 0 | 0 | 1 | 0 | 2 |
| Du Bois | 0 | 0 | 0 | 0 | 1 | 1 |
| Gibson | 20 | 3,807 | 3 | 0 | 3 | 20 |
| Grant | 1 | 0 | 1 | 0 | 0 | 0 |
| Hancock | 1 | 0 | 1 | 0 | 0 | 0 |
| Henry | 0 | 0 | 0 | 0 | 0 | 1 |
| Huntington | 2 | 4 | 1 | 0 | 0 | 0 |
| Jay | 0 | 0 | 0 | 0 | 1 | 1 |
| Knox | 1 | 0 | 1 | 0 | 0 | 4 |
| Lagrange | 0 | 0 | 0 | 0 | 0 | 1 |
| Laporte | 0 | 0 | 0 | 0 | 0 | 1 |
| Madison | 0 | 0 | 0 | 0 | 0 | 1 |
| Marion | 0 | 0 | 0 | 0 | 0 | 2 |
| Owen | 0 | 0 | 0 | 0 | 0 | 1 |
| Perry | 0 | 0 | 0 | 0 | 0 | 1 |
| Pike | 1 | 33 | 0 | 0 | 0 | 3 |
| Posey | 5 | 370 | 1 | 1 | 2 | 12 |
| Spencer | 4 | 20 | 1 | 2 | 0 | 9 |
| St. Joseph | 1 | 0 | 1 | 0 | 0 | 0 |
| Sullivan | 2 | 4 | 1 | 0 | 0 | 4 |
| Vanderburgh | 4 | 35 | 3 | 0 | 0 | 1 |
| Warrick | 1 | 0 | 1 | 0 | 0 | 1 |
| Whitley | 0 | 0 | 0 | 0 | 0 | 1 |
| Decatur | 1 | 0 | 0 | 1 | 0 | 1 |
| Cass | 0 | 0 | 0 | 0 | 0 | 1 |
| Randolph | 0 | 0 | 0 | 0 | 1 | 1 |
| Vigo | 1 | 35 | 0 | 0 | 0 | 2 |
| Ttl. Oct. | 46 | 4,308 | 15 | 5 | 8 | 73 |
| Ttl. Sept. | 43 | 6,433 | 17 | 2 | 11 | 66 |
| Difference | 3 | 2,125 | 2 | 3 | 3 | 7 |

## NEBRASKA

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Cass | 0 | 0 | 0 | 0 | 0 | 1 |
| Dakota | 0 | 0 | 0 | 0 | 0 | 1 |
| Dawes | 0 | 0 | 0 | 0 | 1 | 0 |
| Fillmore | 0 | 0 | 0 | 0 | 0 | 1 |
| Keith | 0 | 0 | 0 | 0 | 0 | 1 |
| Richardson | 0 | 0 | 0 | 0 | 1 | 1 |
| Scotts Bluff | 0 | 0 | 0 | 0 | 0 | 2 |
| Ttl. Oct. | 0 | 0 | 0 | 0 | 2 | 7 |
| Ttl. Sept. | 0 | 0 | 0 | 0 | 2 | 6 |
| Difference | 0 | 0 | 0 | 0 | 0 | 1 |

## IOWA

| County— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Fremont | 0 | 0 | 0 | 0 | 0 | 1 |
| Guthrie | 0 | 0 | 0 | 0 | 0 | 1 |
| Ttl. Oct. | 0 | 0 | 0 | 0 | 0 | 2 |
| Ttl. Sept. | 0 | 0 | 0 | 0 | 0 | 2 |
| Difference | 0 | 0 | 0 | 0 | 0 | 0 |

## MICHIGAN

| Field— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Adams | 0 | 0 | 0 | 0 | 1 | 1 |
| Austin gas | 0 | 0 | 0 | 0 | 1 | 0 |
| Bangor | 3 | 320 | 1 | 0 | 0 | 2 |
| Bloomingdale | 2 | 75 | 1 | 0 | 0 | 3 |
| Broomfield | 0 | 0 | 0 | 0 | 0 | 1 |
| Clayton | 2 | 0 | 0 | 2 | 0 | 3 |
| Columbia | 2 | 150 | 1 | 0 | 2 | 3 |
| Deerfield | 1 | 220 | 0 | 0 | 2 | 6 |
| Edmore | 1 | 0 | 0 | 1 | 0 | 2 |
| Freeman | 13 | 10,232 | 2 | 3 | 6 | 8 |
| Grand Rapids | 42 | 21,949 | 2 | 0 | 16 | 48 |
| Hemlock | 0 | 0 | 0 | 0 | 1 | 0 |
| Hopkinsburg | 0 | 0 | 0 | 0 | 0 | 1 |
| Loomis | 1 | 437 | 0 | 0 | 4 | 3 |
| Monterey | 0 | 0 | 0 | 0 | 1 | 0 |
| Mount Pleasant | 1 | 50 | 0 | 0 | 0 | 1 |
| New Haven | 1 | 225 | 0 | 0 | 0 | 2 |
| New Salem | 6 | 1,855 | 0 | 0 | 4 | 6 |
| Overisel | 0 | 0 | 0 | 0 | 0 | 1 |
| Pine | 0 | 0 | 0 | 0 | 0 | 1 |
| Porter | 0 | 0 | 0 | 0 | 0 | 2 |
| SE. Columbia | 2 | 210 | 0 | 0 | 1 | 4 |
| SE. Grand Rapids | 2 | 300 | 0 | 0 | 2 | 7 |
| Salem | 4 | 653 | 0 | 0 | 2 | 4 |
| Sherman | 0 | 0 | 0 | 0 | 0 | 1 |
| Trowbridge | 0 | 0 | 0 | 0 | 0 | 2 |
| West Branch | 0 | 0 | 0 | 0 | 1 | 4 |
| Winegars | 0 | 0 | 0 | 0 | 0 | 1 |
| Wisner | 0 | 0 | 0 | 0 | 0 | 5 |
| Zeeland | 1 | 0 | 1 | 0 | 1 | 2 |
| Winfield | 0 | 0 | 0 | 0 | 1 | 0 |
| Wildcat | 44 | 60 | 42 | 0 | 16 | 48 |
| Ttl. Oct. | 128 | 36,736 | 50 | 6 | 62 | 172 |
| Ttl. Sept. | 127 | 34,440 | 54 | 5 | 24 | 160 |
| Difference | 1 | 2,296 | 4 | 1 | 38 | 12 |

## EASTERN FIELDS

| Field— | Comp. | Prod. | Dry | Gas | Rgs. | Dig. |
|---|---|---|---|---|---|---|
| Allegany | 88 | 103 | 0 | 0 | 7 | 42 |
| Bradford | 202 | 257 | 0 | 0 | 17 | 93 |
| Middle dist. | 10 | 12 | 0 | 1 | 3 | 11 |
| Butler-Armstrong | 9 | 21 | 2 | 1 | 2 | 7 |
| Northern gas fields | 11 | 0 | 2 | 7 | 7 | 19 |
| S.W. Penna. | 28 | 75 | 6 | 17 | 9 | 47 |
| S.E. Ohio | 36 | 196 | 13 | 9 | 11 | 46 |
| W. Virginia | 50 | 566 | 6 | 36 | 20 | 151 |
| Ttl. Oct. | 434 | 1,230 | 29 | 71 | 76 | 416 |
| Ttl. Sept. | 442 | 1,031 | 35 | 87 | 85 | 438 |
| Difference | 8 | 199 | 6 | 16 | 9 | 22 |

## DRILLING PERMITS ISSUED

Licenses were issued by the Alberta Conservation Board for two new wells in the Lloydminster field. They will be Shaw Petroleums' No. 4, LSD 9, Section 26-49-1w4, and Lloyd-Win's No. 1, LSD 5, Section 24-49-1w4.

In NW¼ Section 14-49-1w4, Triangle's No. 3 is below 293 ft. Highwood-Sarcee Oil Co.'s No. 1, LSD 1, Section 36-47-2w4, is below 990 ft.

The Standard of British Columbia test, C.P.R. Princess' No. 1, LSD 13, Section 22-20-12w4,. is below 3,175 ft. and engaged in coring. The Anaconda Oil Co.'s No. 1, LSD 15, Section 9-22-12w4, is below 3,465 ft. after getting the Madison at 3,209 ft.

# WILDCAT OPERATIONS

## CALIFORNIA

### IMPORTANT WELLS AND SOUTHERN CALIFORNIA WILDCATS

| Company, well, location, and county— | S.T.R. | Depth | Status— |
|---|---|---|---|
| General Pet. Corp., No. 15 Poggi, Torrance, Los A. | 30- 4-13 | 5,183 | will P.B. |
| Union Oil, No. 74 Callender, Dominguez, Los Ang. | 29- 3-13 | 2,985 | sd. sh. drlg. |
| Shell Oil, No. 100 Reyes, Dominguez, Los Angeles | 33- 3-13 | 6,290 | O.S. drlg. |
| Havenstrite, R. E., No. 1 Larronde, Doming., L. A. | 32- 3-13 | 4,477 | sd. sh. drlg. |
| Union Oil, No. 35 Rosecrans, Rosecrans, Los Ange. | 19- 3-13 | 7,627 | O.S. drlg. |
| Barnsdall Oil, No. 1 Santa Fe, Rosecrans, Los An. | 20- 3-13 | 3,865 | sd. sh. drlg. |
| Univer. Cons'd. Oil, No. 18 Trust, Rosecrans, L. A. | 18- 3-13 | 6,090 | sd. sh. drlg. |
| Casa Grande Oil, No. 1 Lopez, San Fernando, L. A. | 1- 2-15 | 2,140 | cmtd. 2,100 |
| Tide Water A. O., No. 12 Porter, Aliso Can., L. A. | 27- 3-16 | 4,769 | O.S. drlg. |
| Tide Water A. O., No. 11 Fernando, Aliso C., L. A. | 27- 3-16 | 5,175 | flow 860 b.d. |
| Tamas Oil, No. 1 Perkins, Newhall, Los Angeles | 14- 3-16 | 2,660 | sd. sh. drlg. |
| Barnsdall Oil, No. 8 R.S.F., Newhall, Los Angeles | 27- 4-17 | 4,593 | sd. sh. drlg. |
| Bernstein, Simon, No. 12 Harbor, Wilmington, L. A. | 35- 4-13 | 3,416 | sd. sh. drlg. |
| Brookline Oil, No. 1 Nix, Wilmington, Los Angeles | 35- 4-13 | 3,665 | pmp. 105 b.d. |
| Dumm Bros. Pet., No. 3 Harbor, Wilmington, L. A. | 35- 4-13 | 3,125 | sd. sh. drlg. |
| Interstate Inv., No. 2 Harbor, Wilmington, Los An. | 35- 4-13 | 2,894 | sd. sh. drlg. |
| Long Beach Dev., No. 3-W Harbor, Wilming., L. A. | 3- 5-13 | 4,057 | cleaning out |
| Long Beach Dev., No. 5-W Harbor, Wilming., L. A. | 3- 5-13 | 3,925 | flow 550 b.d. |
| Long Beach Dev., No. 6-W Harbor, Wilming., L. A. | 3- 5-13 | 3,942 | flow 280 b.d. |
| Long Beach Dev., No. 7-W Harbor, Wilming., L. A. | 3- 5-13 | 4,034 | flow 240 b.d. |
| Long Beach Dev., No. 12-X Harbor, Wilming., L. A. | 2- 5-13 | 3,958 | C.P. 2,925 |
| Morgan, Roy, No. 1 Ruth, Wilmington, Los Angeles | 35- 4-13 | 3,350 | flow 130 b.d. |
| Royalty Service Corp., No. 3 Packard, Wilm., L. A. | 33- 4-13 | 5,716 | pmp. 228 b.d. |
| Royalty Service Corp., No. 7-B Nelson, Wilm., L. A. | 33- 4-13 | 2,198 | sd. sh. drlg. |
| Richfield Oil Corp., No. 32 Pac. Dock, Wilm., L. A. | 35- 4-13 | 3,068 | cmtd. 3,036 |
| Union Pacific R. R., No. 119, Wilmington, Los An. | 3- 5-13 | 3,637 | completing |
| Union Pacific R. R., No. 123, Wilmington, Los An. | 4- 5-13 | 2,396 | sd. sh. drlg. |
| Union Pacific R. R., No. 124, Wilmington, Los An. | 4- 5-13 | 2,151 | sd. sh. drlg. |
| Union Pacific R. R., No. 19-E, Wilmington, Los A. | 3- 5-13 | 3,694 | sd. sh. drlg. |
| Union Pacific R. R., No. 20-E, Wilmington, Los A. | 3- 5-13 | 4,047 | completing |
| Kern Oil, No. 31 Monterey, Montebello, Los Ange. | 2- 2-12 | 5,588 | sd. sh. drlg. |
| Kern Oil, No. 35 Monterey, Montebello, Los Ange. | 2- 2-12 | 3,763 | sd. sh. drlg. |
| Union Oil, No. 1 Wilcox, Montebello, Los Angeles | 11- 2-12 | 6,984 | sd. sh. drlg. |
| Union Oil, No. 6 Wilcox, Montebello, Los Angeles | 11- 2-12 | 6,161 | sd. sh. drlg. |
| Union Oil, No. 35 La Merced, Montebello, Los Ange. | 1- 2-12 | 6,080 | sd. sh. drlg. |
| Albertson Oil, No. 2 Schnakenburg, Monte., Los A. | 3- 2-12 | 2,284 | sd. sh. drlg. |
| Angle Oil, No. 1 Community, Montebello, Los Ang. | 11- 2-12 | 4,480 | sd. sh. drlg. |
| Beacon Oil, No. 1 Caneer, Montebello, Los Angeles | 11- 2-12 | 7,475 | recmtd. 7,460 |
| Bush Oil, No. 1 Mihlfred, Montebello, Los Angeles | 3- 2-12 | 7,694 | O.S. drlg. |
| Bush Oil, No. 1 Zanetti, Montebello, Los Angeles | 3- 2-12 | 7,692 | recmtd. 7,585 |
| Caminol, No. 2-16 Cowan, Montebello, Los Angeles | 2- 2-12 | 7,640 | flow 1,010 b.d. |
| Caminol, No. 3-17 Cowan, Montebello, Los Angeles | 3- 2-12 | 7,255 | sd. sh. drlg. |
| C. A. P. Oil, No. 1 Dutch, Montebello, Los Angeles | 11- 2-12 | 7,191 | O.S. drlg. |
| Crestline Oil, No. 1 Beverly, Montebello, Los Ange. | 11- 2-12 | 7,640 | recmtd. 7,430 |
| Crail Bros., No. 2 Cowan, Montebello, Los Angeles | 1- 2-12 | 7,635 | recmtd. 7,463 |
| Dutch Oil, No. 1 Schelnik, Montebello, Los Angeles | 3- 2-12 | 7,282 | P.B. 7,190 |
| Fremont Oil, No. 1 Aldrich, Montebello, Los Ange. | 12- 2-12 | 5,161 | sd. sh. drlg. |
| Fullerton Oil, No. 2 Scott, Montebello, Los Angeles | 1- 2-12 | 7,630 | recmtd. 7,544 |
| Fullerton Oil, No. 3 Scott, Montebello, Los Angeles | 1- 2-12 | 2,987 | sd. sh. drlg. |
| Graham-Loftus Oil Corp., No. 2 Coffman, M., L. A. | 11- 2-12 | 7,652 | flow 570 b.d. |
| Golden Eagle Oil Corp., No. 1 Lehman, Mon., L. A. | 10- 2-12 | 4,860 | sd. sh. drlg. |
| Golden Eagle Oil Corp., No. 2 Lehman, Mon., L. A. | 10- 2-12 | 3,985 | sd. sh. drlg. |
| Hathaway Oil, No. 2 Dore, Montebello, Los Angeles | 11- 2-12 | 7,475 | completing |
| Herley-Kelly, Inc., No. 2 De Staute, Monteb., L. A. | 11- 2-12 | 3,773 | sd. sh. drlg. |
| Larson Drlg., No. 3 Van Deusen, Montebello, L. A. | 11- 2-12 | 6,630 | sd. sh. drlg. |
| Master Pet., No. 1 Grant, Montebello, Los Angeles | 2- 2-12 | 5,865 | sd. sh. drlg. |
| M. O. C. Oil, No. 1 Zinn, Montebello, Los Angeles | 2- 2-12 | 3,176 | sd. sh. drlg. |
| Mono Oil, No. 1 Foreman, Montebello, Los Angeles | 2- 2-12 | 7,620 | completing |
| Montebello Oil, No. 1 Nordon, Montebello, Los An. | 3- 2-12 | 7,067 | sd. sh. drlg. |
| Pacific-Amer. Oil, No. 1 Groen, Montebello, Los An. | 11- 2-12 | 7,649 | completing |
| Pueblo Oil, No. 2 Bird, Montebello, Los Angeles | 11- 2-12 | 4,382 | sd. sh. drlg. |
| Pongratz Pet., No. 2 Newmark, Montebello, Los A. | 3- 2-12 | 7,653 | O.S. drlg. |
| Sunset Oil, No. 1 Robinson, Montebello, Los Ange. | 12- 2-12 | 6,592 | sd. sh. drlg. |
| Star Pet., No. 1 Caneer, Montebello, Los Angeles | 11- 2-12 | 7,475 | O.S. drlg. |
| Texas, No. 1 Wilcox, Montebello, Los Angeles | 3- 2-12 | 7,687 | recmtd. 7,500 |
| Traders Oil, No. 2 Center, Montebello, Los Angeles | 2- 2-12 | 7,398 | O.S. drlg. |
| United Mont. Oil, No. 1 Lot, Montebello, Los Ange. | 11- 2-12 | 7,666 | completing |
| United Mont. Oil, No. 2 Lot, Montebello, Los Ange. | 11- 2-12 | 7,650 | completing |
| United Mont. Oil, No. 3 Lot, Montebello, Los Ange. | 11- 2-12 | 7,435 | O.S. drlg. |
| Wood-Callahan Oil, No. 1 Thill, Montebello, Los A. | 11- 2-12 | 7,435 | O.S. drlg. |
| Wood-Callahan Oil, No. 2 Todd, Montebello, Los An. | 2- 2-12 | 3,007 | sd. sh. drlg. |
| York Oil, No. 1 Long, Montebello, Los Angeles | 3- 2-12 | 7,655 | flow 601 b.d. |
| York Oil, No. 6 Mulholland, Montebello, Los Ange. | 2- 2-12 | 7,630 | completing |
| Allied Pet. Corp., No. 34 Signal, Long Beach, L. A. | 30- 4-12 | 928 | sd. sh. drlg. |
| Dormax Oil, No. 1 Signal, Long Beach, Los Angeles | 30- 4-12 | 9,896 | cleaning out |
| Richfield Oil Corp., No. 8-B City, Long Beach, L. A. | 29- 4-12 | 4,175 | cmtd. 4,171 |
| El Hondo Pet., No. 1 Venago, Long Beach, Los An. | 24- 4-13 | 9,496 | sd. sh. drlg. |
| Rolling Hills Pet., No. 1 Weston, Palos Verd., L. A. | 27- 4-14 | 6,560 | hd. sh. drlg. |
| Union Oil, No. 24 Chapman, Richfield, Los Angeles | 29- 3- 9 | 4,852 | will redrill |
| Sonwell Oil, No. 1 Anaheim, East Coyote, Orange | 13- 3-10 | 3,384 | pmp. 75 b.d. |
| Union Oil, No. 21 Hole, East Coyote, Orange | 22- 3-10 | 4,673 | O.S. drlg. |
| Master Pet., No. 1 Wright, East Coyote, Orange | 19- 3- 9 | 4,160 | cleaning out |
| Southwest Expl., No. 21 State, Huntington B., Or. | 10- 6-11 | 4,188 | sd. sh. drlg. |
| Southwest Expl., No. 24 State, Huntington B., Or. | 10- 6-11 | 982 | sd. sh. drlg. |
| Owen, W. D., No. 1 Montgomery, Hunting. B., Or. | 36- 5-11 | 3,904 | sd. sh. drlg. |
| Petremont Oil, No. 2 Burton, Huntington B., Oran. | 36- 5-11 | 4,470 | swbg. |
| Alabama Oil, No. 1 Rochester, Huntington B., Oran. | 2- 6-11 | 2,792 | sd. sh. drlg. |

### IMPORTANT WELLS AND NORTHERN CALIFORNIA WILDCATS

| Company, well, location, and county— | S.T.R. | Depth | Status— |
|---|---|---|---|
| Union Oil, No. 2-3 O'Donnell, Santa Maria, Santa B. | 29-10-34 | 5,350 | flow 2,100 b.d. |
| Union Oil, No. 6 Vicente, Santa Maria, Santa Barb. | 21-10-34 | 4,798 | sd. sh. drlg. |
| Gerard, W. R., No. 2 Breneiser, Santa Maria, S. B. | 27-10-34 | 4,790 | sd. sh. drlg. |
| Sunset Oil, No. 1 Shore, Carpinteria, Santa Barbara | 32- 4-25 | 3,413 | fault; abd. |
| Rilling, H. L., No. 1 Camden, South Mountain, Ve. | 13- 3-21 | 1,540 | sd. sh. drlg. |
| Savage Oil, No. 2 Calumet, Shiells Canyon, Ventura | 3- 3-19 | 2,980 | cleaning out |
| Renard Oil Corp., No. 1, Sespe, Ventura | 6- 4-19 | 726 | sd. sh. drlg. |
| Continental Oil, No. 12 Grubb, San Miguelito, Ven. | 24- 3-24 | 7,310 | recmtd. 6,005 |
| Continental Oil, No. 14 Grubb, San Miguelito, Ven. | 24- 3-24 | 2,884 | sd. sh. drlg. |
| C. C. M. Oil, No. 2-B Hobson, Rincon, Ventura | 8- 3-24 | 4,046 | redrlg. 2,685 |
| C. C. M. Oil, No. 28-B Hobson, Rincon, Ventura | 16- 3-24 | 3,894 | gr. sd. drlg. |
| Tide Water A. O., No. 42 V.L.W., Ventura Ave., V. | 23- 3-23 | 9,000 | sd. sh. drlg. |
| Tide Water A. O., No. 44 V.L.W., Ventura Ave., V. | 23- 3-23 | 8,599 | sd. sh. drlg. |
| Tide Water A. O., No. 15 McGonigle, Ven. Ave., V. | 23- 3-23 | 9,670 | sd. sh. drlg. |
| Tide Water A. O., No. 16 McGonigle, Ven. Ave., V. | 23- 3-23 | 7,780 | sd. sh. drlg. |
| Tide Water A. O., No. 120 Lloyd, Ventura Ave., V. | 27- 3-23 | 2,165 | sd. sh. drlg. |
| Tide Water A. O., No. 121 Lloyd, Ventura Ave., V. | 23- 3-23 | 9,194 | sd. sh. drlg. |
| Tide Water A. O., No. 20 Hartman, Vent. Ave., V. | 22- 3-23 | 5,407 | fish D.P. |
| Tide Water A. O., No. 21 Hartman, Vent. Ave., V. | 22- 3-23 | 5,727 | fish D.P. |
| Shell Oil, No. 103 Taylor, Ventura Ave., Ventura | 21- 3-23 | 7,451 | sd. sh. drlg. |
| Shell Oil, No. 106 Taylor, Ventura Ave., Ventura | 29- 3-23 | 5,792 | sd. sh. drlg. |
| Shell Oil, No. 107 Taylor, Ventura Ave., Ventura | 29- 3-23 | 4,880 | sd. sh. drlg. |
| Shell Oil, No. 108 Taylor, Ventura Ave., Ventura | 29- 3-23 | 6,171 | sd. sh. drlg. |
| General Pet. Corp., No. 16 Barnard, Vent. Ave., V. | 28- 3-23 | 8,452 | redrlg. 8,297 |
| Cal. Alliance Pet., No. 1 Hartman, Vent. Ave., V. | 22- 3-23 | 7,480 | O.S. drlg. |
| Brit. Amer. Pet., No. 9 Hartman, Ventura Ave., V. | 21- 3-23 | 3,996 | sd. sh. drlg. |
| Lloyd Corp., No. 3 Dabney, Ventura Ave., Ventura | 23- 3-23 | 10,065 | O.S. drlg. |
| Lloyd Corp., No. 4 Dabney, Ventura Ave., Ventura | 23- 3-23 | 9,590 | sd. sh. drlg. |
| Belridge Oil, No. 1-27, North Belridge, Kern | 1-28-20 | 8,450 | flow 420 b.d. |
| Belridge Oil, No. 28-15, North Belridge, Kern | 28-27-20 | 8,485 | sd. sh. drlg. |
| Abbott, F. E., No. 1 Gamble, Blackwell's Cor., K. | 7-27-20 | 1,103 | sd. sh. drlg. |
| Texas, No. 1 Beer, Devil's Den, Kern | 6-26-19 | 3,370 | sd. sh. drlg. |
| O'Reilly, Frances, No. 2 Seale, Edison, Kern | 5-30-29 | 4,103 | bailing |
| McDonald & Dearin, No. 3 Kernco, Kern Front, K. | 10-28-27 | 1,400 | gr. sh. drlg. |
| D. & D. Oil, No. 6 Kern, Kern River, Kern | 34-28-28 | 630 | rig to pmp. |
| D. & D. Oil, No. 8 Kern, Kern River, Kern | 34-28-28 | 506 | O.S. drlg. |
| D. & D. Oil, No. 10 Kern, Kern River, Kern | 34-28-28 | 420 | O.S. drlg. |
| D. & D. Oil, No. 12 Kern, Kern River, Kern | 34-28-28 | 475 | sd. sh. drlg. |
| D. & D. Oil, No. 13 Kern, Kern River, Kern | 34-28-28 | 186 | sd. sh. drlg. |
| Helm & Smith, No. 15 Kern, Kern River, Kern | 34-28-28 | 672 | pmp. 5 b.d. |
| Ring Oil, No. 8 Shapiro, Mount Poso, Kern | 32-26-28 | 1,710 | rig to pmp. |
| Vedder Pet., No. 21-1 Lambert, Mount Poso, Kern | 21-26-28 | 1,527 | pmp. 135 b.d. |
| Hill and Associates, No. 1-A Hill, Mount Poso, Kern | 35-26-28 | 920 | sd. sh. drlg. |
| Hogan Pet., No. 1 Wible, Mountain View, Kern | 23-30-29 | 5,850 | sd. sh. drlg. |
| Allied Pet., No. 33 Allied, Mountain View, Kern | 19-30-29 | 4,651 | sd. sh. drlg. |
| Texas, No. 2 Jewett, Arvin, Kern | 16-31-29 | 6,482 | pmp. 50 b.d. |
| Texas, No. 1 Mott, Arvin, Kern | 9-31-29 | 2,683 | sd. sh. drlg. |
| Richfield Oil Corp., No. 2 Mott, Arvin, Kern | 9-31-29 | 6,155 | completing |

## KEY TO ABBREVIATIONS USED IN DRILLING REPORTS

Abd., abandoned.
Acd., acidized.
B.O., barrels of oil.
B.P.D., barrels per day.
B.D., barrels daily.
B.P., back pressure.
B.R., building rig.
B. ck., bottom choke.
Br. sh., brown shale.
B.S., basic sediment.
C.&P., cellar and pits.
Cd. or Crd., cored.
C.D., correct depth.
Cg., coring.
Cmtd., cemented.
C.O., cleaning out.
Comp., completed.
Compr., compressor.
C.P., casing pressure, also cement through perforations.
Csg., casing.
D.D., drilling (or drilled) deeper.
Drlg., or Drg., drilling.
Drk. or Dk., derrick.
D.S., drill stem.
D.S.T., drill-stem test.
D.P., drill pipe.
D.&A., dry and abandoned.
Fsg., fishing.
Gbo., gumbo.
G.I., gas injection.
Gr., gravity.
Gr. sd., gray sand.
Grn. sh., green shale.
Hd. sd., hard sand.
H.F.W., hole full of water.
I.P., initial production.
L., lime.
Lnr., liner.
Loc., location.
M.I.M., moving in material.
M.I.R., moving in rig.
M.I.R.T., moving in rotary tools.
M.O.T., milling on tools.
O.I.H., oil in hole.
O.S., oil sand.
O.T.D., old total depth.
O.W.D.D., old well drilling deeper.
O.W.P.B., old well plugging back.
P.B., plugging back.
P.B.P., pulling or pulled big pipe.
P.L., pipe line.
P.L.O., pipe line oil.
Pmpg., pumping.
P.O.P., putting on pump.
P.P., pulled pipe.
Rd. sd., red sand.
Rd. sh., red shale.
Recmt., recemented.
Recvd., recovered.
Rmg., reaming.
Redrlg., redrilling.
Rng., running.
R.O.G., rig on ground.
R.P., rock pressure.
R.U., rigging up.
R.U.R., rigging up rotary.
R.U.S.T., rigging up standard tools.
R.&T., rods and tubing.
S. or Sd., sand.
S.D., shut down.
Sdy. sh., sandy shale.
Sdtrkd. or St., sidetracking.
S.D.P.L., shut down for pipe line.
S.D.O., or S.D.W.O., shut down awaiting orders.
S.G., show gas.
Sh.&L., shale and lime.
S.I., shut in.
S.I.P., shut in, prorated.
S.L.M., steel line measurement.
S.O., show oil.
S.O.G.&W., show of oil, gas, and water.
Spdg. or Spd., spudding.
S.R., straightreaming.
Stdg., standardizing (also standing).
S.W., salt water.
Swbg., swabbing.
T.A., temporarily abandoned.
Tbg., tubing.
T.D., total depth.
T. ck., top choke.
T.P., tubing pressure.
Tr., tract.
Tstd., tested.
U.R., underreaming.
W.I.H., water in hole.
W.O., workover.
W.O.C. or W.O.C.S., waiting on cement to set.
W.O.O., waiting on orders.
W.P., working pressure.
W.S.O., water shutoff.
W.S.S.O.K., water shutoff O.K.
W.S.R. or W.O.S.R., awaiting standard rig.
Wtr., water.

| | | | |
|---|---|---|---|
| Morton, L. C., No. 1 Barlow Farms, Arvin, Kern | 25-31-29 | 5,977 | dry; abd. |
| Western Gulf Oil, No. 44-B, KCL, Fruitvale, Kern | 22-29-27 | 3,857 | cleaning out |
| Western Gulf Oil, No. 12 Red Ribbon, Fruitvale, K. | 27-29-27 | 4,009 | O.S. drlg. |
| Meridian Pet. Corp., No. 2 Deep Test, Fruitvale, K. | 23-29-27 | 3,742 | tested wet |
| Richfield Oil Corp., No. 1, KCL, Fruitvale, Kern | 29-29-27 | 3,680 | sd. sh. drlg. |
| Union Oil, No. 4-23 Bowerbank, Goose Lake, Kern | 25-29-24 | 10,410 | sd. sh. drlg. |
| Trico O. & G., No. 1 Tulare, Delano gas field, Kern | 27-24-23 | 200 | sd. sh. drlg. |
| Standard Oil, No. 3 Mushrush, Wasco, Kern | 7-27-24 | 6,160 | sd. sh. drlg. |
| Union Oil, No. 41-34, KCL, Rio Bravo, Kern | 34-28-25 | 11,176 | O.S. drlg. |
| Superior Oil, No. 1 Smith, Rio Bravo, Kern | 34-28-25 | 10,060 | sd. sh. drlg. |
| Superior Oil, No. 1 Weber, Rio Bravo, Kern | 27-28-25 | 11,197 | completing |
| Standard Oil, No. 1 Ross, Greeley, Kern | 20-29-26 | 10,860 | sd. sh. drlg. |
| Standard Oil, No. 11-20, KCL, Greeley, Kern | 18-29-26 | 10,402 | hd. sh. drlg. |
| Standard Oil, No. 11-21, KCL, Greeley, Kern | 18-29-26 | 9,498 | sd. sh. drlg. |
| Standard Oil, No. 12-5, KCL, NW Greeley, Kern | 7-29-26 | 10,955 | sd. sh. drlg. |
| General Pet. Corp., No. 1 Sullivan, NE Greeley, K. | 12-29-25 | 11,386 | O.S. drlg. |
| Continental Oil, No. 2-D, KCL, Bellevue, Kern | 14-30-26 | 14,051 | P.B. 11,802 |
| Shell Oil, No. 21-28-B, KCL, Ten Section, Kern | 28-30-26 | 8,075 | O.S. drlg. |
| Shell-Ohio, No. 64-12-A, KCL, Strand, Kern | 12-30-25 | 3,682 | sd. sh. drlg. |
| Shell Oil, No. 75-12-B, KCL, Strand, Kern | 12-30-25 | 8,320 | flow 3,342 b.d. |
| Ohio Oil, No. 15-E, KCL, Canal, Kern | 14-30-25 | 8,325 | completing |
| Shell Oil, No. 6-14-A, KCL, Canal, Kern | 14-30-25 | 8,285 | sd. sh. drlg. |
| Richfield Oil Corp., No. 12-33-A, KCL, Tupman, K. | 33-30-25 | 9,331 | whipstk. 8,596 |
| Richfield Oil Corp., No. 41-32-A, KCL, Tupman, K. | 32-30-25 | 7,278 | sd. sh. drlg. |
| Richfield Oil Corp., No. 67-4-B, KCL, Cole's Lv., K. | 4-31-25 | 9,385 | O.S. drlg. |
| Richfield Oil Corp., No. 76-4-B, KCL, Cole's Lv., K. | 4-31-25 | 8,812 | sd. sh. drlg. |
| Standard Oil, No. 20-2, KCL, Cole's Levee, Kern | 9-31-25 | 8,660 | redrlg. 8,330 |
| Standard Oil, No. 20-3, KCL, Cole's Levee, Kern | 9-31-25 | 8,806 | sd. sh. drlg. |
| Standard Oil, No. 20-4, KCL, Cole's Levee, Kern | 9-31-25 | 9,440 | hd. sh. drlg. |
| Ohio Oil, No. 4-F, KCL, Cole's Levee, Kern | 11-31-25 | 9,723 | O.S. drlg. |
| Ohio Oil, No. 5-F, KCL, Cole's Levee, Kern | 10-31-25 | 9,271 | O.S. drlg. |
| Tide Water A. O., No. 81, KCL, Cole's Levee, Kern | 14-31-25 | 10,515 | sd. sh. drlg. |
| Tide Water A. O., No. 65, KCL, Cole's Levee, Kern | 13-31-25 | 2,996 | sd. sh. drlg. |
| Union Oil, No. 56-11, KCL, Cole's Levee, Kern | 11-31-25 | 2,867 | sd. sh. drlg. |
| Baker & Sonne, No. 1 Leyse, Midway-Sunset, Kern | 20-32-23 | 2,730 | dry; abd. |
| Quality Oil, No. 6 W.P., Midway-Sunset, Kern | 27-32-23 | 1,975 | pmp. O. & W. |
| Merritt-Annex Oil, No. 8 Fried, Midway-Sunset, K. | 25-12-24 | 2,494 | pmp. wtr. |
| General Pet. Corp., No. 1 B.V.A., Midway-Sun., K. | 1-32-24 | 10,450 | hd. sh. drlg. |
| Signal O. & G., No. 6 Kendon, Midway-Sunset, K. | 35-32-23 | 1,382 | sd. sh. drlg. |
| Shell Oil, No. 45-9 B.V.A., Midway-Sunset, Kern | 9-32-25 | 9,682 | sd. sh. drlg. |
| National Oil, No. 34 Sunset, Midway-Sunset, Kern | 35-32-23 | 1,335 | sd. sh. drlg. |
| Oxford Oil, No. 6 Sunset, Midway-Sunset, Kern | 27-31-22 | 2,080 | sd. sh. drlg. |
| Ohio Oil, No. 43-3-B, KCL, Paloma, Kern | 3-32-26 | 6,490 | sd. sh. drlg. |
| Western Gulf Oil, No. 74-3-A, KCL, Paloma, Kern | 3-32-26 | 7,784 | sd. sh. drlg. |
| Richfield Oil Corp., No. 81-36 B.V.A., B.V.L., Kern | 36-31-25 | 10,104 | sd. sh. drlg. |
| Shell Oil, No. 37-25-A Pleito, Wheeler Ridge, Kern | 25-11-21 | 2,960 | sd. sh. drlg. |
| Continental Oil, No. 1-F, KCL, San Emidio, Kern | 5-10-21 | 9,227 | prod. test |
| Shell Oil, No. 52-2-13-A, KCL, San Emidio, Kern | 13-11-22 | 11,820 | hd. sh. drlg. |
| Burt & Taylor, No. 1 Rankin, McKittrick, Kern | 30-30-22 | 318 | sd. sh. drlg. |
| Fairfield, F. E., No. 1 Williams, McKittrick, Kern | 2-30-21 | 112 | sd. sh. drlg. |
| Par Pet., No. 1 Line, Antelope Valley, Kern | 32-25-17 | 3,032 | sd. sh. drlg. |
| Standard Oil, No. 51-19-B fee, NE Coalinga, Fresno | 19-19-16 | 6,774 | sd. sh. drlg. |
| Union Oil, No. 57-18 Cook, NE Coalinga, Fresno | 18-19-16 | 6,990 | sd. sh. drlg. |
| Union Oil, No. 75-18 Cook, NE Coalinga, Fresno | 18-19-16 | 3,674 | sd. sh. drlg. |
| Amerada Pet. Corp., No. 3-17 S.P.L., NE Coal., Fr. | 17-19-16 | 7,360 | sd. sh. drlg. |
| Superior Oil, No. 1 Husong, NE Coalinga, Fresno | 18-19-16 | 7,682 | sd. sh. drlg. |
| Wilshire Annex Oil, No. 64-30-B, C Coalinga, Fres. | 30-19-16 | 8,383 | prod. test |
| Lytle, R. S., Agt., No. 53-7-F, SE Coalinga, Fresno | 7-20-16 | 6,990 | sd. sh. drlg. |
| Lytle, R. S., Agt., No. 64-7-F, SE Coalinga, Fresno | 7-20-16 | 7,433 | sd. sh. drlg. |
| Lytle, R. S., Agt., No. 26-18-F, SE Coalinga, Fresno | 18-20-16 | 5,081 | sd. sh. drlg. |
| Univer. Cons'd. Oil, No. 8-24-C, SE Coalinga, Fresno | 24-20-15 | 6,003 | sd. sh. drlg. |
| Texas, No. 3 Exeter fee, SE Coalinga, Fresno | 6-20-16 | 8,220 | completing |
| Texas, No. 1 Anderson, SE Coalinga, Fresno | 6-20-16 | 5,493 | sd. sh. drlg. |
| Standard Oil, No. 62-13-C fee, SE Coalinga, Fresno | 13-20-15 | 6,980 | sd. sh. drlg. |
| Standard Oil, No. 66-13-C fee, SE Coalinga, Fresno | 13-20-15 | 2,275 | sd. sh. drlg. |
| Standard Oil, No. 75-13-C fee, SE Coalinga, Fresno | 13-20-15 | 6,192 | sd. sh. drlg. |
| Standard Oil, No. 31-19-F fee, SE Coalinga, Fresno | 19-20-16 | 5,388 | sd. sh. drlg. |
| Superior Oil, No. 1-B Cagle, SE Coalinga, Fresno | 6-20-16 | 3,880 | sd. sh. drlg. |
| Superior Oil, No. 4 Huffman, Kettleman North, Fr. | 29-21-17 | 9,651 | sd. sh. drlg. |
| K. N. D. A., No. 25-22-Q, Kettleman North, Kings | 22-22-18 | 7,980 | O.S. drlg. |
| K. N. D. A., No. 38-22-Q, Kettleman North, Kings | 22-22-18 | 7,160 | sd. sh. drlg. |
| K. N. D. A., No. 56-22-Q, Kettleman North, Kings | 22-22-18 | 7,053 | sd. sh. drlg. |
| K. N. D. A., No. 36-26-Q, Kettleman North, Kings | 26-22-18 | 5,582 | sd. sh. drlg. |
| K. N. D. A., No. 47-26-Q, Kettleman North, Kings | 26-22-18 | 6,785 | sd. sh. drlg. |
| K. N. D. A., No. 41-28-Q, Kettleman North, Kings | 28-22-18 | 7,590 | sd. sh. drlg. |
| Standard Oil, No. 27-19-J, Kettleman North, Fresno | 19-21-17 | 9,898 | gr. sh. drlg. |
| Standard Oil, No. 72-19-J, Kettleman North, Fresno | 19-21-17 | 10,018 | sd. sh. drlg. |
| Standard Oil, No. 27-7-Q, Kettleman North, Kings | 7-22-18 | 9,240 | sd. sh. drlg. |
| Standard Oil, No. 3-7-Q, Kettleman North, Kings | 7-22-18 | 8,568 | cleaning out |
| Standard Oil, No. 5-7-Q, Kettleman North, Kings | 7-22-18 | 5,896 | sd. sh. drlg. |
| Standard Oil, No. 63-7-Q, Kettleman North, Kings | 7-22-18 | 6,274 | sd. sh. drlg. |
| Standard Oil, No. 32-17-Q, Kettleman North, Kings | 17-22-18 | 6,551 | sd. sh. drlg. |
| Standard Oil, No. 61-17-Q, Kettleman North, Kings | 17-22-18 | 2,997 | sd. sh. drlg. |
| Standard Oil, No. 72-17-Q, Kettleman North, Kings | 17-22-18 | 6,074 | will redrill |
| Standard Oil, No. 76-17-Q, Kettleman North, Kings | 17-22-18 | 5,488 | sd. sh. drlg. |
| Standard Oil, No. 83-17-Q, Kettleman North, Kings | 17-22-18 | 5,565 | sd. sh. drlg. |
| Standard Oil, No. 52-21-Q, Kettleman North, Kings | 21-22-18 | 6,040 | sd. sh. drlg. |
| Standard Oil, No. 74-21-Q, Kettleman North, Kings | 21-22-18 | 5,556 | sd. sh. drlg. |
| Standard Oil, No. 85-21-Q, Kettleman North, Kings | 21-22-18 | 8,035 | flow 1,610 b.d. |
| Standard Oil, No. 32-27-Q, Kettleman North, Kings | 27-22-18 | 7,550 | sd. sh. drlg. |
| Compass Oil, No. 1 Points, Deer Creek, Tulare | 8-23-26 | 3,120 | sd. sh. drlg. |
| Priest Valley Pet., No. 1 Greve, Priest V., Monterey | 22-20-12 | 1,197 | sd. sh. drlg. |
| Buttes Oilfields, Inc., No. 6 Buttes, Marysville, Sut. | 1-15- 1 | 4,391 | sd. sh. drlg. |
| Seaboard Oil, No. 1 Howard, Bear Creek, Merced | 6- 8-11 | 4,363 | sd. sh. drlg. |
| Cons'd. Pet., No. 1 Ashurst, Los Pinos, San Benito | 11-17-11 | 2,006 | sd. sh. drlg. |
| Texas, No. 1 Welch, Rio Vista gas field, Sacramento | 5- 3- 3 | 3,680 | sd. sh. drlg. |

# OKLAHOMA

Week Ended November 11

## NORTHERN OKLAHOMA

### Caddo County

**Sinclair Prairie Oil Co. No. 1 Gorman, SW NW NW Sec. 1-16-13w. S. heavy oil; cd. 6,442-49 ft.; Wdfrd. 6,600 ft.; Hntn. 7,157 ft.; cd. 7,439-44 ft.; rec. S.O.; drlg. 7,454 ft.**

### Canadian County

**W. R. Ramsey's No. 1 Mansfield, C NW NE Sec. 16-14-9w. Lytn. 6,800-6,920 ft.; N.S.; drlg. 8,707 ft.**

### Cleveland County

**Nels Burton No. 1 Boggs, NE NE SE Sec. 16-9-2w. 2nd Wlx. 7,585 ft.; T.D. 7,646 ft.; P.B. 7,473 ft.; shot and acd.; P. 113 B.O.P.D.; 20 to 50% wtr.**

**Nels-Burrton No. 1 Hirsch, NW NW NE Sec. 17-9-2w. O.W.P.B.; O.T.D. 7,692 ft.; T.D. 7,695 ft.; swbd. 250 B.F. in 24 hrs.; 10% B.S.**

**Sinclair-Prairie No. 1 Ward, SE SE SE Sec. 30-7-1. Hntn. 6,185 ft.; Vla. 6,405 ft.; open 30 min. at 6,800 ft., rec. S W.; P.B. to 6,782 ft.; swb. 106 B.O. in 24 hrs.; hy. blk. oil; drlg. 7,436 ft.**

### Comanche County

**Mid Night Oil No. 1 Howe, NW NW NE Sec. 30-2-13w. O.W.D.D.; O.T.D. 703 ft.; fsg. 998 ft.**

### Creek County

**Sunray Oil Co. No. 1 Harris, SW SW NE Sec. 30-14-7. T.D. 2,927 ft.; est. 370,000 cu. ft. gas.**

### Garvin County

**Duckworth & Jennings' No. 1 Bowie, NW NE SE Sec. 3-4-3. W.O.C. 60 ft.**

**Robinson & Midco's No. 1 Clay, SW SW NW Sec. 21-4-3. Simp. dense 3,145 ft.; cd. 3,277-94 ft.; rec. 13 ft. sdy. dolo.; T.D. 3,503 ft.; S.D.**

### Grady County

**Alma Oil Co.'s No. 5 Pettit (O.W.D.D., SE SE ES Sec. 11-4-8w. T.D. 3,660 ft.; S. 2½ B.O.P.D.; R.U. to pmp.**

**Sinclair Prairie's No. 4 Charleston, NE NE SE Sec. 27-5-8w (O.W.D.D.); gas 3,330-50 ft.; sd. 3,918-25 ft.; T.D. 3,967 ft.; ga. 43,600,000 cu. ft. gas; S.I.**

### Grant County

**Magnolia Pet. Co.'s No. 1 Margay-Johnson, SW SW NE Sec. 29-25-8w. Fsg. 6,059 ft.**

### Greer County

**Butler's No. 1-A Meyers, NE SE NW Sec. 25-7-21w. T.D. 1,228 ft.; D.&A.**

### Jackson County

**English Drlg. Co.'s No. 1-A Aetna Life, SE SE NE Sec. 26-3-20w. Drld. into old hole; T.D. 864 ft.; rng. csg.**

**Bob Helton et al's No. 1 Lee, NE SE NW Sec. 36-2-19w. T.D. 1,360 ft.; S.D.**

### Jefferson County

**H. M. Weir No. 1 Carmichael, NE NE SW Sec. 23-7s-7w. Drlg. 3,525 ft.**

### Kingfisher County

**Anderson-Prichard No. 1 Geis, C NE SW Sec. 15-18-9w. Lytn. 6,450-6,510 ft.; T.D. 8,507 ft.; B. to 7,375 ft. and bdgd. hole; ga. 500,000 cu. ft. gas.**

**Ace Gutowsky No. 1 Lankford, NE NE SE Sec. 34-17-6w. Miss. 7,014 ft.; Woodford 7,531 ft.; Manr. 7,562 ft.; Wlx. 8,105 ft., 2nd Wlx. 8,275 ft.; T.D. 8,330 ft.; S.D.O.**

### Kiowa County

**Bollen-Dillard & Roberts No. 1 Holcomb, NE NE SW Sec. 25-7-19w. Drlg. 1,470 ft.**

**Frank Dillard et al's No. 1 Hobbs, SE SE NW Sec. 35-6-17w. Gr. wsh. 555 ft.; drlg. 593 ft.**

**Hagerling et al No. 1 Bozeman, SE SE NE Sec. 14-5-18w. Drlg. 1,286 ft.**

**C. J. Hagerling No. 1 Kimray, SW SW NW Sec. 36-5-18w. T.D. 1,592 ft.; S.D.**

### Lincoln County

**Black Gold No. 1 Locquchment, NE NE NE Sec. 28-14-6. T.D. 3,175 ft.; est. 5 B.O.P.D.; S.D.**

**R. L. Kemp's No. 1-A Burke, NE SW NE Sec. 20-17-6. Prue 2,864-2,908 ft., T.D.; comp. at 25 B.O.P.D.**

**Summitt Drlg. Co.'s No. 1 Percival, SE SE SE Sec. 24-12-3. 1st Wlx. 5,475 ft.; T.D. 5,504 ft.; to run Schlmb.**

### Noble County

**Franks & Ellis' No. 1 Stranka, SW SW NW Sec. 35-24-1w. S.D. 1,310 ft. for D.P.**

### Oklahoma County

**Hall & Briscoe No. 1 Thompson, SW SW NE Sec. 28-13-1. S.O. 4,803-27 ft.; T.D. 6,058 ft.; P.B. 5,185 ft.; C.O. to 4,850 ft.; p. 100 B.O. and 10 B.W.P.D.; comp.**

### Osage County

**Midco Oil Co.'s No. 1 Osage, NE NE SW Sec. 17-22-8. S.D. 2,847 ft.**

### Payne County

**Helmerich & Payne's No. 1 Berry, Sec. 14-17-6. Drlg. 4,165 ft.**

**C. R. Hoagland No. 1 Stanolind, SE SE SW Sec. 27-18-4. Miss. 3,800 ft.; T.D. 3,905 ft.; D.P. stk.**

### Pontotoc County

**Crescent Oil Co.'s No. 2 Thompson, NE NW SW Sec. 29-3-4. Drlg. 165 ft.**

### Pottawatomie County

**Neustadt et al No. 1 Howeth, NE SE NE Sec. 14-6-4. Sd. and S.S.O. 3,455-60 ft.; S.D. 5,060 ft.**

### Sequoyah County

**Thompson Bros. No. 1 Ruby, NW NW NE Sec. 30-12-22. Hntn. 1,451 ft.; T.D. 1,912 ft. (cor.); S.D.**

### Washita County

**Continental Oil Co. No. 1 Proctor, C NW Sec. 28-10-20w. T.D. 14,582 ft.; fsg. for 75 jts. of D.P.**

## SOUTHERN OKLAHOMA

### Choctaw County

**Letchfield & Kirksly No. 1 Schuester, SW SE SW Sec. 13-6s-14. Cd. 1,169-81 ft., L.&sd.; W.O.C. 1,146 ft.**

**Clyde Ross et al No. 1 Hardy, SE SE NW Sec. 21-7s-15. T.D. 1,662 ft.; S.D.**

### Cotton County

**Scarborough et al's No. 1 Ash, NE NE SE Sec. 7-4-10w. Drlg. 1,220 ft.**

### Jefferson County

**Fred Land et al's No. 1 Barrett, NE SE SE Sec. 14-8s-6w. Sd. 1,852 ft., S.O.; D. P. stk. at 1,100 ft.; T.D. 1,890 ft.**

### Marshall County

**Hughes et al No. 1 Vittitto, C NE SE Sec. 11-5s-4e. O.W.D.D.; O.T.D. 7,100 ft.; T.D. 7,110 ft.; S.D.**

**Johnson et al No. 1 Godfrey, SW SE NE Sec. 14-6s-6e. Vla. 2,627 ft; S.S.O.; drlg. 3,123 ft.**

### Stephens County

**Ray Johnson's No. 1 Baker, C SE NW Sec. 35-2s-6w. Drlg. 230 ft.**

### Tillman County

**Magnolia Pet. Co.'s No. 1 Amyx, NW SE SE Sec. 17-3-16w. Drlg. 2,060 ft.**

# KANSAS

Week Ended November 11 (Descriptions are East unless marked otherwise)

### Barton County

**C. E. Ash et al's No. 1 Montgomery, NW NW NW Sec. 11-16-11w. Drlg. 2,020 ft.**

**Aylward Prod. et al's No. 1 Harzman, C W½ NW SW Sec. 33-16s-11w. Lans. 3,056 ft.; Arb. 3,350-56 ft., T.D.; S. 19 B.O. and 12 B.W. in 19 hrs.**

**B. B. & M. Drlg. Co.'s No. 1 Krier, CEL SE SE Sec. 30-16-11w. Pay 3,327 ft.; S. 22 B.O. in 2 hrs.**

**Crown Pet. Co. No. 1 Marchand, NE SE NW Sec. 13-20-11w. Drlg. 2,910 ft.**

**Seaney & Clampitt's No. 1 Schauf, CSL E½ SW Sec. 1-16-12w. Lans. 3,051 ft.; S.S.O. and wtr. in core 3,142-56 ft.; Arb. 3,358-91 ft.; shots 2,880-2,905 ft.; show W.&S.S.O.; T.D. 3,393 ft.; D.&A.**

### Butler County

**Allison & Talbott's No. 1 Zink, SE SE NE Sec. 32-29-5. Drlg. 1915 ft.**

**Carey & Jennings No. 1 Kelly, C SW Sec. 20-27-4. S.D. 2,660 ft.**

**Cromwell & Lewis No. 1 Stern, NW NW NW Sec. 27-27-6e. M.I.M.**

**Marylyn Oil et al No. 1-A Hoard, SW NE NE Sec. 28-29-8. Lans. 1,625 ft.; S.S.O. 2,095 ft.; S.O. 2,355-60 ft.; Miss. 2,836-41 ft.; 200 ft. O.I.H. in 8 hrs.; rig burned; D.&A.**

**C. H. Pechin et al's No. 1 Hartenbower (O.W.D.D.), NW NW NW Sec. 16-29-6. O.T.D. 3,257 ft.; Peru sd. 2,476-2,530 ft.; C.O.**

### Coffey County

**Hollett's No. 1 Butler, SE SW SE Sec. 28-20-15. T.D. 2,202 ft.; S.D.O.**

### Cowley County

**Garden's No. 1 Rahn, SW SW NW Sec. 13-34-5. Bart. 2,936 ft.; S. 2 B.O.P.H.; S.D.O.**

**E. B. Shawyer's No. 1 Henderson, C W½ NE NE Sec. 4-33-6. Base Miss. 3,536 ft.; drlg. 3,547 ft.**

**Earl Wakefield's No. 1 Steel, C E½ SW SE Sec. 6-32-6. Drlg. 505 ft.**

### Douglas County

**Greenway Oil Co.'s No. 1 Grosdedier, C E½ SE NE Sec. 24-13-20. S.D. 600 ft.**

### Ellis County

**Virginia Drlg. et al's No. 1 Craig, CEL SE SE Sec. 8-11-16w. Drlg. 1,980 ft.**

### Franklin County

**Security O. & G. Co. No. 1 Teall, C SW NW Sec. 11-17-17. Caving 1,200 ft.**

### Greenwood County

**Chas. Barker's No. 1 Gregg, SW NW SE Sec. 35-25-12. (O.W.D.D.). O.T.D. 1,660 ft.; drlg. 1,955 ft.**

**A. A. Hinze et al's No. 1 Hester, NW SW NE Sec. 1-22-12. S.D. 510 ft.**

**Marylyn Oil Co.'s No. 1 Burke, NE NE SW Sec. 27-24-11. R.U. mch.**

### Jefferson County

**E. W. Mosbacker et al's No. 1 McLaughlin, SW NE NW Sec. 4-10-20. Drlg. 950 ft.**

**C. L. Sheedy et al's No. 1 O'Neill, SE SW NW Sec. 34-8-19. Arb. 2,842 ft., N.S.; S.D.O.**

### Kingman County

**Skelly Oil Co. No. 1 Miller, CSL N½ NE Sec. 31-27-10w. Set 7-in. 4,067 ft.; R.U. S.T.**

### McPherson County

**Westgate-Greenland's No. 1 McCulle, CEL NE SW Sec. 29-17-1w. Miss. 2,850 ft.; Hntn. 2,955 ft.; Vla. 3,133-90 ft., T.D.; cg.**

### Marion County

**Polhamus et al's No. 1 Noone, C SW NE Sec. 18-18-3. Drlg. 50 ft.**

**Montgomery County**

**Larke & Whortan No. 1 Clemmer, C SW SW Sec. 21-32-15. Arb. 1,530 ft.; set 5-in. csg.; W.O.C.**

**Osage County**

**J. M. Edwards No. 1 Detrick (O.W.D.D.), C NW SE Sec. 21-14-15. O.T.D. 1,206 ft.; S.G. in sh. 1,618-24 ft.; S.D. 1,650 ft.**

**Pratt County**

**Shelly Oil Co. No. 1 Royse, C SW Sec. 9-28-11w. Lans. 3,604 ft.; Vla. 4,246-49 ft.; T.D. 4,268 ft.; S.S.O.; 802,000 cu. ft. gas.**

**Rice County**

H. B. Garden et al's No. 1 Misener, C N½ NW NE Sec. 21-21-7w. R.R.

**Fred Jones et al No. 1 Bennke, NW SW NW Sec. 25-18-10w. Congl. 3,181 ft.; quartzite 3,209-14 ft., T.D.; P. 268 B. O. in 8 hrs.; pot. 805 B.O.; comp.**

**Phoenix Drlg. No. 1 Linville, SW SW SE Sec. 4-20-10w. Simp. 3,375 ft.; Arb. 3,388 ft.; comp. at 15 B.O.P.D.**

**Saco Oil's No. 1 Habeger, SE SE SW Sec. 12-18-10w. Drlg. 2,140 ft.**

**Vickers Pet. Co. No. 1-A Rodenberg, CNL NW¼ Sec. 8-18-10w. Lans. 2,930 ft.; Arb. 3,265-81 ft., T.D. N.S.**

**Rooks County**

**Broadview Oil No. 1 Baxter, NE SW SW Sec. 35-8-16w. Lans. 3,180 ft.; S.S.O.; T.D. 3,263 ft.; P. 89 B.O. in 7 hrs.; pot. 269 B.O.P.D.**

**Russell County**

Ray Shaffer et al's No. 1 Shaffer, NE NE SW Sec. 9-13-11w. Drlg. 1,245 ft.

**Stafford County**

**Continental Oil Co. No. 1 Keller, SE SE SE Sec. 15-24-13w. S.O. 3,733-43 ft. cd. 4,111-16 ft. and rec. 5 ft. sat.; T.D 4,116 ft.; 3,900 ft. O.I.H.**

**Woodson County**

**Billerman et al's No. 1 Rauscher, CSL NW SE Sec. 19-23 15. Dry sd. 1,460-**

**Bird, Hanley & Sheedy No. 1 Pingrey, C S½ SE Sec. 22-25-15. Spd.**

## MISSOURI

**Adair County**

J. W. Eddington et al's No. 1 Clark, NW NE SE Sec. 8-63-14w. Drlg. below 200 ft.

Ward McGinnis' No. 1 Laughlin, SE SE SW Sec. 16-53-34w. Drlg. 300 ft.

Morrow & Rodgers and Benedum-Trees' No. 1 Cooley, SE SE NW Sec. 33-64-17w. S.O. 871-86 ft.; T.D. 965 ft.; may acidize.

**Andrew County**

E. F. Neely et al's No. 1 Shores, SE SE SE Sec. 12-60-37w. Drlg. 1,335 ft.

**Bolinger County**

**Delmund Oil No. 1 Cooper, SE SE SE Sec. 14-29-9e. S.D. 1,780 ft.**

**Buchanan County**

**Miller et al's No. 1 Carrough, C SE SE Sec. 24-57-35w. T.D. 95 ft.; M.I.M.**

**Butler County**

**Coastal Pet. et al No. 1 Pierson, SW NE NW Sec. 27-22-6e. S.D. 149 ft. (cor.)**

**Charlton County**

**L. E. Mummert et al's No. 1 Rickert, NW NE SE Sec. 26-54-20w. Loc.**

**Clay County**

**Pabelo Dev. Co.'s No. 5-A Robb, NW NW SE Sec. 36-52-32. T.D. 600 ft., S.G.; S.D.O.**

**Clinton County**

**C. E. King et al's No. 1 Vanderau, SE NE SW Sec. 18-55-31w. Drlg. 1,480 ft.**

**Daviess County**

**H. H. Francis' No. 1 Louis, SW NW SW Sec. 29-59-27w. Drlg. ahead.**

**DeKalb County**

**Geo. W. Moore No. 1 McQuate, NE SW SW Sec. 11-57n-31w. Miss. 1,075 ft.; S.D. csg. 1,500 ft.**

**Holt County**

**Brin & Nathan No. 1 Decker, C NW NW** Sec. 1-61-38w. S.D. for water.

**Jackson County**

**Hulse & Christopher's No. 1 Wiston, NE NW SE Sec. 22-49-32w. S.D. 510 ft. to D.D.**

**Knox County**

W. H. Oberithier et al's No. 1 Campbell, C NE Sec. 18-61-12w. C.&P.

**Mercer County**

**Geo. W. Moore No. 1 Moss, NW SW SE Sec. 30-65-24w. Hntn. 1,273 ft. Drlg. 1,879 ft.**

**Platte County**

Geo. A. Vincent et al's No. 1 Dillingham, NE SW Sec. 16-53-34w. Pits; M.I.M.

**Putnam County**

Benedum & Trees' No. 1 Cooley, SE SE NW Sec. 33-64-17w. T.D. 965 ft.; cmtg. to test.

**Randolph County**

**A. A. Ash et al's No. 1 Alexander, C SE Sec. 14-55-13w. Loc.**

**Ray County**

**Loomis-Jordan No. 1 Macey, NE SW NW Sec. 10-53-27w. S.O. 330 ft., T.D.; set csg.**

**Schuyler County**

T. E. Baldwin's No. 1-A Johnson, NW NE NE Sec. 21-65-15w. Loc.

**St. Charles County**

Brooks et al's No. 1 Stewart, SE SE SE Sec. 4-46-2e. S.D.O. 507 ft.

## ARIZONA

**Apache County**

Franco-Arizona Oil Co.'s No. 1 Government, SE NE Sec. 14-14n-26e. T.D. 2,345 ft.; set 2,000 ft. 9⅝-in. csg.

**Cochise County**

**Funk Benevolent Corp. No. 1 fee, SE NE Sec. 27-13s-30e. Fsg. 6,668 ft.; S.S.G.**

**Maricopa County**

**Ben Case No. 1 Johnson, NE¼ Sec. 12-1s-5w. Loc.**

Legco Drlg. Co. No. 1 Battles, SW SE Sec. **25-1n-4w. Loc.**

**Sam F. Reaves No. 1 Fuqua, NW NW NE Sec. 34-1n-1w. S.D. 4,117 ft.**

Sam F. Reaves' No. 1 King, SW SE Sec. 33-1n-4w. Loc.

**Peoples O. & G. Co. No. 1 Gardner, SE¼ Sec. 2-1n-3e. S.D. 500 ft.**

**Pima County**

**R. W. Schenck No. 1 Boyce, Sec. 22-19s-17e. S.D. 350 ft.**

**Yavapai County**

**Ari-Copa Drlg. & Mining Co. No. 1 Puntenney, SW¼ Sec. 27-18n-2w. Drlg. 264 ft.; (last report).**

**Chino Valley Oil Dev. Co. No. 1 State, Sec. 20-18n-2w. Drlg. 1,080 ft.; S.O. 1,020-40 ft.**

**Yuma County**

Chas. T. Lark, Sec. 7-7s-14w. Loc.

Yuma Valley O. & G. Co. No. 1 Musgrove, N½ SW NW NE Sec. 11-11s-25w Shows of oil between 480 and 1,640 ft.; T.D. 2,360 ft.; (last report).

## IOWA

**Fremont County**

Oscar Gruber's No. 1 fee, C SW SE Sec. 8-67n-40w. Base Ft. Scott 750 ft.; T.D. 1,065 ft.; S.D. for csg.

**Guthrie County**

F. E. Hunt et al's No. 1 McConnell, C SE SE Sec. 11-78n-30w. Drlg. below 65 ft.

## NEBRASKA

**Cass County**

**Golden Rod Oil Co. No. 1 Sparer, SE SE SE Sec. 8-11-13e. Drlg. L. 1,205 ft.**

**Dakota County**

Peder Skriver's No. 1 Armour, NE NE NE Sec. 33-28-8. O.T.D. 2,964 ft.; R.U. to D.D.

**Fillmore County**

Dan Kornfeld's No. 1 Mathis, NE NE NE Sec. 22-5-1w. Drlg. 920 ft.

**Keith County**

California-Nebraska Oil, Ltd.'s No. 1 Guststuehm, NW NW NW Sec. 21-14-37w. Dak. 2,772 ft.; S.O. 2,895-2,901 ft.; T.D. 3,114 ft.; S.D. fuel.

**Richardson County**

Pawnee Royalty's No. 1 Boice, CSL N½ NE NE Sec. 18-1-16e. Hntn. 2,276-82 ft., T.D.; (cor.); pmp. 230 B.O. in 24 hrs.; pmp. 122 B.O. 2nd 24 hrs.; R.U.; D.D.

**Scotts Bluff County**

Albert Wood et al's No. 1 McHenry, SE NE NE Sec. 33-23-57w. T.D. 625 ft.; U.R. 8-in.

J. A. Fairy Pet.'s No. 1 McCulley, C SE SE Sec. 35-23-58w. S.D. 2,035 ft.

# ARKANSAS

**Clark County**

Coker Oil Corp.'s No. 1 H. C. and H. H. Cabe, 330 ft. NE cor. NW NE Sec. 3-10-21. Set 5⅛-in. csg. 244 ft.; reported S.O. 352 ft.; set 4-in. csg. 364 ft.; swbd. fr. wtr.; no S.O.; S.D. 415 ft.

Coker Oil Corp.'s No. 2 H. C. and H. H. Cabe, NW cor. NW NE Sec. 8-10s-20w. Reported S.O.&G. 392-98 ft.; set 6-in. csg. 392 ft.; T.D. 400 ft.; W.O.C.

**W. S. King's No. 1 H. Ross, 640 ft. S, 359 ft. W, NE cor. S½ SW Sec. 3-10-21. Drlg. rd. sh. 1,793 ft.**

**W. P. Wilson's No. 1 Hamilton & Mathews, C W½ NE NE Sec. 31-10s-20w. Run 10-in. csg. 41 ft.; T. Nac. 358 ft.; S.S.O.; reported S.O.&G. 437 ft.; drlg. sdy. sh. 1,278 ft.**

**Columbia County**

**Ark. Fuel Oil Co.'s No. 1-B King, 1,980 ft. S and E, NW cor. Sec. 21-17-20. Set 9⅝-in. csg. 2,128 ft. (cor.); drlg. rd.&gr. sh. 5,280 ft.**

**Atlantic Ref. Co.'s No. 1-B Pine Woods Lbr. Co., C SE NW Sec. 16-18-22. Drlg. rd.&gr. sh. 4,167 ft.**

**Hunt Oil Co.'s No. 1 McWilliams, C NW NW Sec. 15-18-19. Drlg. 2,320 ft.**

**Lion Oil Ref. Co.'s No. 1 Warnock est., C NW NW Sec. 15-18-22. Drlg. rd. sdy. sh. 6,510 ft.**

**J. K. Mahoney's No. 1 E. Riley, C NW NE Sec. 14-18-19. Drlg. gr. sh. 2,573 ft.**

**Normandie Oil Co.'s No. 2 Dees, C SE SE Sec. 24-17-20. Set whpstk. 5,300 ft.; O.T.D. 5,738 ft.; P.B. 4,500 ft.; drld. out and set whpstk. 4,636 ft.; set whpstk. 4,678 ft.; cg. 7,476 ft.; prep. run csg.**

**Shell Oil Co., Inc.'s No. 1 Keith, C SE SE Sec. 9-18-22. Set 13⅜-in. csg. 150 ft.; T.D. 155 ft.; W.O.C.**

**Shell Oil Co., Inc.'s No. 2 Merritt, C NW SW Sec. 15-17-20. 5½-in. csg. 7,646 ft.; drlg. plug.**

**Southwood Oil Co.'s No. 1-C A. L. Poindexter, C N½ SW SE Sec. 23-17-20. Set 6-in. csg. 7,657 ft.; T.D. 7,657 ft.; flwg. into pits.**

**Standard Oil Co. of La.'s No. 1-B Gunnels, 571 ft. W, 585 ft. S, NE cor. NW SW Sec. 19-17-19. Set 6-in. csg. 7,503 ft.; W.O.C.**

**Standard Oil Co. of La.'s No. 1-B N. Johnson, 655 ft. W, 660 ft. N, SE cor. SE SE Sec. 9-16-22. R.U.**

**Standard Oil Co. of La.'s No. 1-B Lewis, 660 ft. N, 560 ft. E, SW cor. SW NE Sec. 19-17-19. Drlg. sd.&sh. 5,599 ft.**

**Standard Oil Co. of La.'s No. 1-A Longino Unit, C NE SW Sec. 19-17-19. Set 9⅝-in. csg. 2,149 ft.; drlg. sdy. sh. 5,564 ft.**

**Standard Oil Co. of La.'s No. 1 Oda Jameson et al, 660 ft. N, 664 ft. W, SE cor. Sec. 14-17-19. Drlg. rd. sh.& sd. 7,130 ft.**

**Standard Oil Co. of La.'s No. 1 Petty Stave, C SE SE Sec. 4-17-21. Drlg. hd. L.&sh. 6,118 ft.**

**Standard Oil Co. of La.'s No. 1 R. S. Warnock, C NW NW Sec. 36-16-20. Drlg. sd.&sh. 5,946 ft.**

**Superior Oil Co.'s No. 1 Martel, C SW SW Sec. 10-18-22. Set surf. csg. 210 ft.; W.O.C.**

**Tide Water Seaboard's No. 1 Clark, C SE NE Sec. 16-18-19. Set 10¾-in. csg. 2,514 ft.; csg. 7,288 ft.**

**G. H. Vaughn and Deep Rock Oil Corp.'s No. 1 J. Jones unit, C SW NE Sec. 21-17-20. Set whpstk. 3,640 ft.; drld. to 4,678 ft.; hole 4° off; abd. loc. and skd. rig to C SW NE and set 6-in. csg. 7,626 ft.; T.D. 7,636 ft.; completing.**

**Craighead County**

**Tennark, Inc., No. 1 R. M. Martin, SE cor. NE NE Sec. 35-14-3e. S.D. 4,010 ft.**

**Lafayette County**

**East Texas Ref. Co.'s No. 2-A Patton, 373 ft. S, 652 ft. E, NW cor. NW SE Sec. 24-16-24. Jnkd. and abd. hole 3,524 ft.; skd. 100 ft. S and spd.; set 5½-in. csg. 3,480 ft.**

**East Texas Ref. Co. et al's No. 1-C C. Warren et al, C NE SE NW Sec. 24-16-24. S.D. 10 ft.**

**Lonoke County**

**Cabot Drlg. Club's No. 1 LeMay, 330 ft. SE cor. SE SW Sec. 26-4n-9w. S.D. 20 ft.**

**Miller County**

**W. C. Feazel's No. 1 Heflin, 455 ft. N, 350 ft. E, SW cor. frac. Sec. 17-20-27. Drlg. 600 ft.**

**Nevada County**

**O. T. Clark's No. 1 T. M. Bemis, 330 ft. NW cor. NW NE Sec. 23-10s-22. M. I.M.**

**Ouachita County**

**A. B. Turner et al No. 1 Cook Est., C NW SW Sec. 27-15-18. Rng. 7-in. csg.; 1,588 ft.; T.D. 1,618 ft.; W.O.C.**

**Pulaski County**

**Coker Oil Corp.'s No. 1 Huffman, 330 ft. NW cor. NW SW SW Sec. 29-4n-11w. 8¾-in. csg. 206 ft.; S.D. 1,763 ft.**

**Sevier County**

**R. A. McArthur's No. 1 Bell est., 20 ft. SE cor. SE SW Sec. 29-9s-32w. Set 12½-in. csg. 100 ft.; S.D. 390 ft.**

**Union County—Schuler**

**Lion Oil Ref. Co.'s No. 7-B Morgan, 330 ft. NW cor. W½ SE Sec. 18-18-17. T. Jones sd. 7,546 ft.; T.D. 7,730 ft.; D.S. stk.; cutting out.**

**Union County—Other**

**Barnsdall Oil Co.'s No. 1 Cameron, C SW SW Sec. 36-19-17. R.U.**

**E. G. Bradham's No. 4-A H. C. McKinney, 306 ft. N, 660 ft. E, SW cor. SW SW Sec. 30-17-15. Hole 120° off; P.B. 2,150 ft.; hole 11° off; abd. and skd. 20 ft. N; set 10-in. csg. 100 ft.; T.D. 2,167 ft.; set 7-in. csg. 2,167 ft.; R.U. C.T.**

**Crestrock Oil Co.'s No. 1 E. Riley, 330 ft. S, 250 ft. W, NE cor. NW SW Sec. 9-16-15. S.O. 2,370-80 ft. and 2,390-2,400 ft.; 6-in. csg. 2,415 ft.; T.D. 2,415 ft.; perf. 2,370-74 ft.; pmpd. est. 200 B.P.D.; small S.O.; pmpd. 300 B.F. in 8 hrs., 8% oil; W.O.**

**Delta Drlg. Co. et al's No. 1 J. E. Bull, 330 ft. SE cor. SW NW Sec. 6-18-13. Tstd. oil and S.W. in Meakin sd. and oil and mud in Graves sd.; tstg. sat.**


**Burke-Greis Oil Corporation**

*Producers of Petroleum*

Cosden Bldg. Tulsa, Okla.



For QUICK, ACCURATE TESTS Use CURTIN CENTRIFUGES

**No. 3420 . . . 15 c.c. machine. Cranks and heads interchangeable with 100 c.c. machines.**

**Simple in design . . . Ruggedly built . . . Require no special care . . . Gear Ratio and throw of crank produce required speed with no strain. Curtin Centrifuges meet all *A.S.T.M. Standard Method D-96-35* and *A.P.I. Code No. 25* requirements. Fully descriptive literature upon request.**

W·H·CURTIN & CO. Inc.

HOUSTON U.S.A. TEXAS

sd. in Blsm.; tstd. S.W. 2,710-18 ft., set 7-in. csg. 2,730 ft.; perf. 2,583-86 ft.; flwg. 10 B.P.H., 50% wash wtr.; ½-in. ck.; T.D. 2,730 ft.

Delta Drlg. Co.'s No. 1 C. T. Grace, C SE SE Sec. 31-12-14. Set 10¾-in. csg. 815 ft.; T. Sur. L. 6,701 ft.; T. por. 6,708 ft.; S.W. 6,712 ft.; tstd. mud, S.W.&S.O. 6,701-27 ft.; T.D. 6,819 ft.; W.O.

Lion Oil Ref. Co. No. 9-A Hays, Sec. 4 16-15. O.W.W.O.; O.T.D. 7,255 ft.; P.B 2,325 ft.; rpd. csg. 2,276-80 ft.; S.O.. pmpd. est. 700 B.P.D. S.W.; S.S.O. arng. recmt. 2,325 ft.; W.O.C.

Oil Prod., Inc.'s No. 1 Moore, C SE SE Sec. 1-17s-14w. T. Crain sd. 3,043 ft.; S.D. 3,066 ft.; W.O.

## FLORIDA

### Baker County

Swift Creek Oil Co.'s No. 1 Howell Turpentine Co., approx. C Sec. 15-4s-19e. Drk.

### Dade County

Wm. G. Blanchard et al's No. 1 Everglades, 200 ft. E, 100 ft. N, SE cor. Sec. 31-53s-35e. Loc.

### Levy County

Florida Oil Discovery Co.'s No. 2 Cedar Key, SW SW NE Sec. 9-15s-13e. T.D. 5,266 ft.; W.O. heavier rig.

### Nassau County

St. Mary's River Oil Corp.'s No. 1 Hillard Turpentine Co., NW cor. NW SE Sec. 19-4n-24e. S.D. 4,762 ft., sd.

### Suwannee County

Wm. G. Blanchard et al's No. 1 Lucy Cotton, 774 ft. N, 153 ft. W, SE cor. NE Sec. 35-3s-11e. S.D. 184 ft.

J. W. Phillips Oil Expltn. Co.'s No. 1 Shilkett, NW NW Sec. 14-4s-14e. No report.

## GEORGIA

### Clinch County

Georgia Resources, Inc.'s No. 1 Gillican, Dist. 4. S.D. 400 ft., gr. sh.

## ALABAMA

### Barbour County

W. B. Hinton's No. 1 fee, Sec. 14-9n-26e. T.D. 5,546 ft.; T.A.

### Choctaw County

Joe Modisett et al's No. 1 McCorvey, SE cor., SW SW Sec. 20-9n-2w. S.D. 7,520 ft.

### Houston County

Columbia Oil Co.'s No. 1 State Ld., SE cor. NE NE Sec. 8-2n-29e. S.D. 2,150 ft.; Selma clk.

### Lawrence County

Mid-Southern Pet. Co.'s No. 1 W. R. Jackson, 150 ft. NL, 500 ft. EL, Sec. 30-7-6. S.D. 570 ft., hd. L.

### Washington County

Texon Drlg. Co.'s No. 1 Stallworth Naval Stores, Sec. 25-5n-4w. S.D. 2,706 ft.

## MISSISSIPPI

### Attala County

Kosciusko Oil Co.'s No. 1 Jones, 600 ft. NW cor., Sec. 5-15n-9e. Loc.

P. & M. Oil Co.'s No. 1 J. A. McMillin, 300 ft. SW cor., SE SE Sec. 26-13n-5e. Loc.

### Claiborne County

Claiborne Co. Dev. Co. No. 1 Ruth Hayden, S½ SE Sec. 55-11n-2e. O.W.WO.. O.T.D. 2,949 ft.; S.D. 3,272 ft., sh.

### Copiah County

Triangle Drlg. Co.'s No. 1 W. W Broome, 153 ft. SW cor. SW SE Sec. 1-10n-8e. T.D. 10 ft.; spd.; S.D.; W.O. heavy rig.

### Harrison County

Big Ridge Oil Co.'s No. 1 Hengin, C NE Sec. 13-7s-10w. S.D. 2,700 ft.

### Hinds County

Byrd-Frost et al's No. 1 Gaddis Farms, 275 ft. SE cor. SE SE Sec. 12-6n-3w. Spd.

Miss. Basin O. & G. Co.'s No. 1 Gaddis farms, 150 ft. E, 250 ft. S, NW cor. NW SW Sec. 17-7n-2w. Drlg. clk. 5,510 ft.

### Itawamba County

G. C. Grasty et al's No. 1 Ky. Lbr. Co., 1,320 ft. E, 660 ft. S, C Sec. 7-10s-10e. Twisted off D.S., skdd. 24 ft. S and spd.; set 10¾-in. csg. 170 ft.; drlg. 377 ft.

### Issaquena County

A. A. Chaney, Tr.'s No. 1 J. C. Mohanna, Sec. 13-18n-3e. R.U.

Locke & Mellard's No. 1 W. Gary, 660 ft. SE cor., NW Sec. 14-9n-6w. Loc.

### Kemper County

M. R. Crabb et al's No. 1 W. T. Caldwell, NW SE Sec. 25-9n-15w. 10¾-in. csg. 86 ft.; reported S.O.&G. 2,100 ft.

### Lamar County

Ira H. Larr et al's No. 1 M. Simmon, Sec. 32-3n-14w. S.D. 100 ft.

South Miss. Pet. Corp.'s No. 1 Pearly Morris, 500 ft. S, 570 ft. E, C Sec. 4-2n-14w. S.D. 3,029 ft.

### Monroe County

Willmut G. & O. Co.'s No. 1 Roberts, NW Sec. 18-13s-17w. R.U.

### Pike County

S. R. Crouch's No. 1 Cupit, 360 ft. N, 660 ft. W, SE cor. NE SW Sec. 25-2n-7e. S.D. 864 ft.

### Prentiss County

Home Dev. Co.'s No. 1 Mrs. A. Allen, Sec. 8-7s-9e. Drlg. dolo. 1,312 ft.

### Simpson County

Cleve Love No. 1 N. E. Gardner, SW cor. SW NE Sec. 1-10n-17w. S.D. 3,150 ft., Wlx.

### Wilkinson County

Louisiana Progress Oil Co.'s No. 1 A. M. Young, 792 ft. N, 88° 30' W SE cor., Sec. 40-4n-1e. R.U.

### Yazoo County

Conroe-Wilcox's No. 1 Stubblefield, Sec. 25-12-1w. M.I.M.

Harry Hanbury et al's No. 1 Brooks, SW Sec. 17-10-2. M.I.M.

Edgar Johnson et al's No. 1 Broomfield, SE SE Sec. 2-10-3. R.U.

Jones & O'Brien's No. 2 Stevens, C SE NE Sec. 13-10-3. T.D. 1,545 ft.; ran survey; rng. 10-in. csg. 1,543 ft.; T. oil sd. 4,475 ft.; cg. sd. 4,481 ft.

Jones & O'Brien Bros.' No. 3 Stevens, C SW SW Sec. 12-10-3. Drk.

Union Producing Co.'s No. 1 Friley, 1,944 ft. W, 678 ft. S NE cor., SE Sec. 14-10-3. Set 10¾-in. csg. 1,540 ft.; drlg. sh. 4,185 ft.; prep. core.

Union Prod. Co.'s No. 1 Stevens, C NW NW Sec. 13-10n-3w. T. Cretaceous 4,395 ft.; rec. 4½ ft. shly. L.&sd. with O.S. 4,407-27 ft.; cd. sdy. sh. 4,670-4,770 ft.; Eutaw O. sd. 4,865-77 ft.; D.S.T. 4,860-77 ft. rec. 2,900 ft. oil 11 min.; ran survey to 5,235 ft.; rmd. out core hole 5,295 ft.; cd. sd. 5,493-5,508 ft.; S.O.; D.S.T. 5,486-5,508 ft.; rec. 3,800 ft. S.W. in 13 min.; ⅝-in. cks. T. &S.; W.P. 10 lb.; cg. in Tuscaloosa rd. sh. 5,630 ft.

Union Prod. Co.'s No. 2 G. C. Woodruff, 3,220.5 ft. S, 680.7 ft. E, NW cor. SE Sec. 13-10-3. R.U.

Yazoo Refinery, Inc.'s No. 1 Frank Brooks, W½ SE NW Sec. 17-10-2w. R.U.

# LOUISIANA

## N. LOUISIANA WILDCATS

### Bossier Parish

Gulf Ref. Co.'s No. 20 C. B. Hodges, 3,131 ft. N, 1,388 ft. W, SE cor. Sec. 24-16-12. T. Pett. L. 5,298 ft.; T. Travis Pk. 5,590 ft.; drlg. hd. gr. sh. 7,035 ft.

Oils Finance Corp.'s No. 9 Ark. fee, 200 ft. N, 400 ft. W, SE cor. NE SE Sec. 15-19-11. R.U.; S.D.

Premier Inv. Co.'s No. 7-B Kendrick, 150 ft. N, 1,980 ft. W, SE cor. Sec. 22-19-11. D.S.T. 1,029-42 ft.; S.O.&G.; set 9-in. csg. 1,770 ft.; T.D. 1,785 ft.; W.O.C.

Triangle Drlg. Co.'s No. 3-A Herold et al, 1,668 ft. E, 322 ft. S, NW cor. NW Sec. 13-17-12. Drlg. sh. 1,700 ft.

Union Prod. Co.'s No. 1-A Herold, 1,326 ft. S, 1,322 ft. W, NE cor. Sec. 29-17-11. M.I.M.

### Caddo Parish

R. E. Allison's No. 3 Ellerbe et al, 330 ft. N, 1,980 ft. E, SW cor. Sec. 27-18-14. T.D. 5,560 ft.; T. L. 5,547 ft.; set 5½-in. csg. 5,546 ft.; swbg. failed; cg. 5,568 ft.

Ark. La. Gas Co.'s No. 1 Bell, 1,213 ft. N, 1,067 ft. E, SW cor. Sec. 6-17-16. Set 9⅝-in. csg. 3,246 ft.; T. Pettit L. 5,629 ft.; D.S.T. 5,627-77 ft.; rec. 15,000,000 cu. ft. gas; set 5½-in. csg. 6,169 ft.; T.D. 6,400 ft.; to perf. in Pet. L.

Burnham Drlg. Co.'s No. 2 Wilkinson, 1,650 ft. N, 990 ft. W, SE cor. Sec. 33-22-16. Set 10-in. csg. 105 ft.

David Crawford et al's No. 1 Lloyd, 3,940 ft. N, 1,000 ft. E, SW cor. Sec. 29-17-13. No show in Jeter; cd. Pet.; gave sh.&dns. L.; drlg. 5,837 ft.

L. I. Davis' No. 1 Williams, C NW NW Sec. 14-15-15. R.U.; S.D.

Gerhig Co.'s No. 1 Tompkins, 1,321 ft. W, 660 ft. N, C Sec. 18-21-15. Set 7-in. csg. 1,569 ft.; W.O.C.

Jones Oil Co.'s No. 1 Pitts, 250 ft. S, 674 ft. W, NE cor. Sec. 24-20-16. Tstd. dry 1,679 ft., S.O.; acdzd. with 3,000 gal.; W.O.

P. N. McCullough's No. 4 Hart, 673 ft. N. 620 ft. E, SW cor. Sec. 21-21-16. Set 10-in. csg. 60 ft.; S.D. 350 ft.

McElmury & Hamilton's No. 1 Mattson, 591 ft. W, 1,866 ft. S, NE cor. NW Sec. 1-20-16. Drlg. sh. 1,050 ft.

D. R. Manziel's No. 2 Brooks, 438 ft. S, 250 ft. E, NW cor. Sec. 17-21-15. S.D. 1,068 ft.

Milam Prod. Co.'s No. 1 Patrick, 1,985 ft. S, 90 ft. W, NE cor. NW¼ Sec. 1-20-16. 4½-in. csg. 1,358 ft.; T.D. 1,471 ft.

J. Ray Murray et al's No. 1 Standard Oil Co. fee, 330 ft. N, 200 ft. E, SW cor. Sec. 12-21-16. Set 7-in. csg. 1,500 ft.; acd. with 1,000 gal. at 1,720 ft.; S.O.; T.D. 2,312 ft.; set 5-in. csg. 2,255 ft.; T.D. 2,312 ft.; pmpg. S.W.; S.O.

Riggs & Lester's No. 2-A Seybert, 218 ft. N, 4,242 ft. E, C Sec. 17-20-15. Set 5½-in. 1,338 ft.; T.D. 1,640 ft.; will acd.

Stanolind O. & G. Co. No. 1, 131 Dillon hrs., C SE NE Sec. 14-21-15. Ran Schlmb. 9,109 ft.; T. Smkvr. L. 8,952 ft.; ran Schlmb. 10,164 ft., T.D.; set 7-in. csg. 10,154 ft.; reported prep. test.

Joe G. Strahan's No. 1-B Stiles, 330 ft. S, 1,000 ft. E, NW cor. Sec. 32-21-16. Drlg. sh. 1,837 ft.

Sultana Drlg. Co.'s No. 1 Bain, 198 ft. W, 480 ft. N, SE cor. Sec. 4-23-15. Drlg. 3,777 ft.

Texas Co.'s No. 5 La. Co. fee, 2,159 ft. S, 436 ft. E, NW cor. NE¼ Sec. 1-20-16. 6⅝-in. csg. 1,331 ft.; T.D. 1,480 ft.; W.O.C.

Texas Co.'s No. 10-B Noel, 990 ft. S, 330 ft. W, NE cor. NW¼ Sec. 14-21-15. Set 6⅝-in. csg. 1,502 ft.; acd. 4,000 gal.; W.O.S.R. 1,648 ft.

Texas Co.'s No. 1 Shea, 3,300 ft. S, 63 ft. E, NW cor. NE Sec. 1-20-16. R.U.

Travis & Red Iron Drlg. Co.'s No. 1 Chandler et al, 819 ft. S, 2,086 ft. E, NW cor. Sec. 5-23-15. Set 9⅝-in. csg. 961 ft.; fsg. D.S. 5,220 ft.

Waldron & Barnes' No. 1 Ark. Fuel Oil fee, 438 ft. N, 1,368 ft. E, SW cor. NW SE Sec. 1-20-16. Drlg. sh. 423 ft.

### Caldwell Parish

Critchett & Woods (formerly E. T. Oakes) No. 1 Kyles, NE cor. SW NE Sec. 18-11-3e. Fsg. D.S. 4,975 ft.

### Claiborne Parish

Lisbon Expltn. Co. No. 1 Roberta Vaughn, 330 ft. N, 660 ft. E, SW cor. NW NE Sec. 36-21-5. O.W.D.D.; O.T.D. 5,313 ft.; recmtd. 7-in. csg. 5,343 ft.; T. Tr. Pk. 5,405 ft.; T. lower Marine form. 7,833 ft.; gas and dist. sd. 8,817-48 ft., hd. and tight; set 5-in. csg. 8,881 ft.; perf. 8,354-83 ft. and stk. gun; to test perf. before fsg.

Oakes & Shadrup's No. 1 Lloyd, 660 ft. S, 722 ft. E, C Sec. 10-20-5. Drlg. sh.& L. 2,407 ft.

### De Soto Parish

N. W. Hunter's No. 1 Anders-LeBlanc, C NW SE Sec. 5-11-14. Set 10-in. csg. 590 f.; D.ST. 1,954-74 ft.; rec. 150 ft. mud, 25 min.; S.S.O.; S.D. wtr. 2,655 ft.

Dewey Jaun's No. 1 Frost Lbr. Ind., 6,600 ft. SE cor. SW Sec. 14-22-3e. R.U.

David Murray's No. 1 Russell, 50 ft. N, 500 ft. W, SE cor. NE NW Sec. 12-11-16. D.S.T. 2,725-36 ft.; rec. 1,000 ft. S.W. in 33 min.; cd. S.W. sd. 2,736-38 ft.; cg. 2,741 ft.

C. H. Tuttle No. 2-A Wemple, E NW cor. SW¼ Sec. 14-12n-11w. T. bkn. sd. 2,640 ft.; 6⅝-in. csg. 2,557 ft.; tstg. 2,698 ft.; C.O.

### Franklin Parish

Continental Oil Co.'s No. 1 J. T. Carroll et al, 330 ft. NW cor. Sec. 26-13-8e. Drlg. anhy. 3,818 ft.

### La Salle Parish

Smith Bros.' No. 1 Kenney, 660 ft. S, 150 ft. W, C Sec. 7-10-2e. T. sd. 1,517 ft.; set 8¼-in. csg. 1,517 ft.; T.D. 1,527 ft.; tstg. 1,527 ft.

### Morehouse Parish

Union Prod. Co. No. 1-A Tensas-Delta, 1,894 ft. W, 1,584 ft. S, NE cor. SE Sec. 8-22-4. Set 20-in. csg. 125 ft.; 16-in. csg. 712 ft.; set 10¾-in. csg. 2,448 ft.; T. salt 8,114 ft.; drlg. anhy. 9,020 ft.

United Carbon Co.'s No. 3 Tulsa fee, Sec 4-21-5. Drlg. 2,000 ft.

### Natchitoches Parish

Jack Lent et al's No. 1 Walker, C NE NE Sec. 9-10-10. 10-in. csg. 63 ft.; reported small S.O. 2,018 ft.; D.S.T. 2,007-18 ft.; rec. 32 jts. S.W.

Popkins & DeSoto Bros.' No. 1 Peavy-Wilson Lbr. Co., 330 ft. NW cor. SE NW Sec. 36-7n-9w. O.W.W.O.; O.T.D 500 ft.; S.D. 2,700 ft.

### Sabine Parish

Ed Bailey's No. 1 Hale, 330 ft. NW cor. NE NW Sec. 6-7-12. S.D. for wtr. 1,228 ft.

A. R. Chestnut et al's No. 1 Sepulvedo, 990 ft. N, 330 ft. E, SW cor. Sec. 4-7-13. T. clk. 2,022 ft.; set 6-in. csg. 2,027 ft.; W.O.C.

Hunter Co.'s No. 2-B Sabine Lbr. Co.. C SE SE Sec. 7-7-13. Fsg. D.S. 2,160 ft.

M. Lanza's No. 1 Phares, 330 ft. SE cor. NE SE Sec. 5-5-12. Drlg. sh. 2,293 ft.

N. B. Livingston's No. 1 Bowman Hicks, 660 ft. SE cor. SW Sec. 36-9-14. R.U.

W. E. Manners' No. 1 Stephens, C SW SE Sec. 17-9-11. Drlg. 2,850 ft.

E. R. Phillips' No. 1 Craig, 335 ft. S, 330 ft. E, NW cor. NW SE Sec. 22-9-13. S.D. 1,936 ft.; W.O.

W. L. Posey No. 1 Rivers, C NW NW Sec. 26-9-13. 6-in. csg. 2,147 ft.; T.D. 2,150 ft.; T. clk. 2,145 ft.; tstd. S.O. and S.D. 2,350 ft.

W. M. Quick No. 1 Sabine, SE cor. NE SE Sec. 8-7-13. 6-in. csg. 2,061 ft.; T. D. 3,547 ft.; P.B. 2,350 ft.; tstg. small S.O.&wtr.

H. M. Sneed No. 1 Leone, SW cor. NW SE Sec. 8-7-13. T.D. 1,962 ft.; 6-in. csg. 2,061 ft.; W.O.S.R.; T.D. 2,116 ft.

S. E. Stack's No. 1 Gray, 330 ft. SW cor. Sec. 4-7-13. T. clk. 2,025 ft.; set 7-in. csg. 2,028 ft.; W.O. wtr.

J. E. Stick's No. 1 Weber, 330 ft. SE cor. SW NE Sec. 8-7-13. Set 10-in. csg. 42 ft.; W.O.C.

Sutton-Zwolle Oil Co.'s No. 3 Sabine, 1,650 ft. S, 660 ft. E, NW cor. NE Sec. 23-7-14. S.D.

### Union Parish

W. E. Hope O. & G. Co.'s No. 6 Frost Lbr. Ind., Sec. 26-22-3. Set 6-in. csg. 2,092 ft.

Interstate Nat. Gas Co.'s No. 95 fee, Sec 36-22-3e. Drlg. sh. 2,067 ft.

Memphis Nat. Gas Co.'s No. 1 Day, 951 ft. S, 277 ft. E, NW cor. Sec. 24-22-3e. Set 12½-in. csg. 174 ft.

H. L. Woods' No. 1 Union Power, 1,980 ft. E, 660 ft. S, NW cor. Sec. 29-21-3. R.U.

### Webster Parish

Geo. Barham's No. 2 Bodcaw, Sec. 15-21-10. O.W.D.D.; O.T.D. 4,732 ft.; cutting lnr. to dpn.

Hunt Oil Co.'s No. 3 Stewart, C NE NW Sec. 29-21-10. Drlg. L.&sh. 5,374 ft.

Hunt Oil Co.'s No. 4 Stewart, 480 ft. S, 835 ft. E, NW cor. SW Sec. 32-21-10. Drlg. 4,426 ft.

Magnolia Pet. Co.'s No. 3 Cox, 672 ft W, 737 ft. N, SE cor. SE NE Sec. 22-21-10. Drlg. rd. sh. 5,890 ft.

Oliphant Oil Co.'s No. 2 Banks, 410 ft. S, 660 ft. E, NW cor. Sec. 2-20-10. Set 9⅝-in. csg. 5,611 ft.; drlg. sdy. sh. 7,380 ft.

Stanolind O. & G. Co.'s No. 4 Pardee, 660 ft. SE cor. Sec. 25-21-10. T. Tr. Pk. 5,829 ft.; 9⅝-in. csg. 5,950 ft.; drlg. 5,829 ft.; 9⅝-in. csg. 5,950 ft.; 9⅝-in. csg. 5,863 ft.; hole off 4°, whpstk. 6,989 ft.; set 2nd whpstk. 7,258 ft.; drlg. rd. sh.&sd. 7,417 ft.

Woodley Pet. Co.'s No. 2 Couch, 810 ft. S, 510 ft. W, NE cor. SW Sec. 35-21-10. 13⅜-in. csg. 683 ft.; set 9⅝-in. csg. 5,775 ft.; drlg. sdy sh. 7,277 ft.

## SOUTH LOUISIANA FIELDS

### Abbeville—Vermilion Parish

Continental Oil Co. No. 1 David Meaux, Sec. 9-12s-3e. T.D. 11,359 ft.; T. gas sd. 11,318 ft.; D.S. stk.; P.B. and sidetracked; drlg. 7,420 ft.

Continental Oil Co. No. 1 Franciol, Sec. 67-12s-3e. Drk.

Stanolind O. & G. Co.'s No. 1 Lebocut, Sec. 33-12s-3e. Drlg. sh. 7,930 ft.

### Bancroft—Beauregard Parish

Republic Prod. Co.'s No. 9 Columbia Ld. & Tmbr. Co., Sec. 15-6s-13w. T.D. 7,330 ft.

Republic Prod. Co.'s No. 1 G. T. Whitman, Sec. 15-6s-13w. Drlg. sd.&sh. 6,420 ft.

Republic Prod. Co.'s No. 1-B Whitman, Sec. 15-6s-13w. R.U.

Republic Prod. Co.'s No. 3 L. Whitman, Sec. 15-6s-13w. T.D. 7,662 ft.; 5½-in. csg. 7,662 ft.

### Bateman Lake—St. Mary Parish

Texas Co. No. 1 St. Mary Parish Sch. Bd., Sec. 16-16s-12e. Gas sd. 11,169-79 ft.; cd. sd. dist. cut 11,516-19 ft.; T.D. 11,589 ft.; 7⅝-in. csg. 11,579 ft.; sdy. sh. show dist. 11,554-59 ft.

Texas Co.'s No. 3 Way Bayou, Sec. 21 16s-12e. Loc.

### Baton Rouge—East Baton Rouge Parish

W. V. Bowles' No. 2 Richard Community, Sec. 45-7s-1e. T.D. 6,522 ft.; 5½-in. csg. 6,522 ft.; perf. csg. 6,500-15 ft.; tstd. S.W.; drlg. out cmt.

W. V. Bowles et al's No. 2 University Hills, Sec. 68-7s-1w. R.U.

Guaranty Oil Co. No. 2 Morgan, Sec. 65-7s-1w. T.D. 6,530 ft.; 5½-in. csg. 6,450 ft.; swbd. S.W.; S.D.

Wm. Helis' No. 3-B Duplantier, Sec. 68-7s-1w. T.D. 6,500 ft.; 7-in. csg. 6,478 ft. I.P. 243 B.P.D.; 10/64-in. ck.

Wm. Helis' No. 5-A L.S.U., Sec. 67-7s-1w. T.D. 7,248 ft.; run 7-in. csg.

Wm. Helis' No. 4 Materiste, Sec. 66-7s-1w. T.D. 6,572 ft.; T. sd. 6,460 ft.; 7-in. csg. 6,464 ft.; I.P. 245 B.P.D.; 11/64-in. ck.

T. G. Markley et al No. 3 Knox, Amis-Farnbacher, Sec. 66-7s-1w. T.D. 6,478 ft.; run 7-in. csg. 6,465 ft.; tstg.

Marshland Oil Co.'s No. 1 J. B. McDonald, Sec. 45-7s-1e. T. sd. 6,477 ft.; T.D. 6,488 ft.; I.P. 204 B.P.D.; 11/64-in. ck.

Sugarfield Oil Co.'s No. 2 Irby Nichols, Sec. 45-7s-1e. T.D. 4,390 ft.; 5½-in. csg. 4,390 ft.; perf. csg. 4,345-67 ft.; I.P. 65 bbl. net oil, 75% S.W.; ¼-in. ck.

Texas Canadian Oil Co.'s No. 2 Bogan-Davidson, Sec. 67-7s-1w. 6-in. csg. 18 ft.; drlg. sd.&sh. 3,100 ft.

### Bay St. Elaine—Terrebonne Parish

Texas Co. No. 19 State-Bay St. Elaine, Sec. 18-22s-18e. T.D. 6,500 ft.; 9⅝-in. csg. 6,400 ft.; T.D. 7,028 ft.; 7-in. csg. 7,028 ft.; perf. csg. 6,440-6,500 ft. tbg. plugged; drlg. 6,502 ft.; I.P. 90 B.P. D.; 1/16-in. ck.

**Bayou des Glaise—Iberville Parish**

Humble O. & R. Co. No. 1-B Wilbert, Sec. 78-8s-8e. T.D. 3,025 ft.; 13⅜-in. csg. 3,000 ft.; T. salt 4,101 ft.; T.D. 4,162 ft.; S.D.
Humble O. & R. Co.'s No. 2-B Wilberts, Sec. 78-8s-8e. Loc.

**Caillou Island—Terrebonne Parish**

Texas Co.'s No. 12 State, Sec. 20-23s-20e. T.D. 4,982 ft.; sdtrkd.; drlg. sdy. sh.& L. 4,817 ft.
Texas Co.'s No. 61 State, Sec. 17-23s-20e. T.D. 4,309 ft.; 7-in. csg. on bttm.; perf. csg. 4,132-4,270 ft.; I.P. 270 B.P.D.; ¼-in. ck.

**Cameron Meadows—Cameron**

Magnolia Pet. Co. No. 25 Cameron Meadows, Sec. 21-14s-13e. T.D. 6,955 ft.; 7-in. csg. 6,494 ft.; perf. csg. 6,280-90 ft.; tstg.

**Chacahoula—La Fourche Parish**

Sun Oil Co. No. 1 Cypress, Sec. 75-15s-15e. 13⅜-in. csg. 1,842 ft.; T. salt 6,072 ft.; T.D. 6,088 ft.; P.B. 2,100 ft.; sdtrkd.; T.D. 6,553 ft.; fsg.; sdtrkd.; drlg. sh.&L. 5,399 ft.
Sun Oil Co.'s No. 6 Dibert, Stark & Brown, Sec. 70-15s-15e. M.I.R.
Sun Oil Co. No. 2 Dodge Sunberry, Sec. 65-15s-15e. S.D. 4,250 ft.; T.A.

**Chalkley Field—Cameron Parish**

Humble O. & R. Co.'s No. 1 Cameron Sch. Bd., Sec. 16-12s-6w. Loc.
Humble O. & R. Co.'s No. 5 K. B. Hanzen, Sec. 9-12s-6w. Drlg.
Humble O. & R. Co.'s No. 5 Sweet Lake Ld. & Oil Co., Sec. 7-12s-6w. Drlg. sh. &L. 7,619 ft.
Shell Oil Co., Inc.'s No. 4 Hanzen. T.D. 8,990 ft.; rmg.

**Charenton—St. Mary Parish**

Pan American Prod. Co.'s No. 3-A H. Ecuer, Sec. 11-13s-9e. Drlg.
Pan American Prod. Co.'s No. 17 Laws Realty Co., Sec. 31-13s-10e. Drlg. 6,342 ft.
Pan American Prod. Co.'s No. 6 South Coast Corp., Sec. 31-13s-10e. S.D. 7,207 ft.

**Cheneyville—Rapides Parish**

Amerada Pet. Corp.'s No. 7 Weil Co., Sec. 54-1s-2e. R.U.
Gulf Oil Corp.'s No. 2 M. Pope, Sec. 56-1s-2e. T.D. 5,751 ft.; 5½-in. csg. 5,751 ft.; perf. csg. 5,736-50 ft.; I.P. 308 B.P.D.; ¼-in. ck.
S. W. Richardson's No. 4 Weil, Sec. 54-1s-2e. T.D. 5,796 ft.; 5½-in. csg. 5,796 ft.; perf. csg. 5,752-88 ft.
S. W. Richardson's No. 5 Weil, Sec. 53-1s-2e. Drlg. sh. 3,026 ft.

**Creole—Cameron Parish**

Superior Oil Co.'s No. 9 State, Gulf of Mex., Twp. 15s-8w. Drlg. sh. 4,420 ft.

**Darrow—Ascension Parish**

Humble O. & R. Co.'s No. 25 Community, Sec. 31-10s-2e. T.D. 4,770 ft.; 7-in. csg. 4,745 ft.
Humble O. & R. Co.'s No. 26 Community, Sec. 30-10s-2e. R.U.
Kiva Oil Co. No. 1 Duplessis, Sec. 69-10s-2w. S.D. 2,523 ft.

**Dog Lake—Terrebonne Parish**

Texas Co. No. 23 State, Sec. 5-22s-16e. T.D. 7,429 ft.; P.B.; sdtrkd.; T.D. 6,105 ft.; P.B.; sdtrkd.; cg. sd. 6,841 ft.

**Eola—Avoyelles Parish**

Amerada Pet. Corp.'s No. 3 Glaze, Sec. 6-2s-3e. T.D. 8,556 ft.; 5½-in. csg. 8,555 ft.; perf. csg. 8,435-30 ft.; I.P. 65 bbl. in 2 hrs.; ¼-in. ck.
Amerada Pet. Corp.'s No. 4 Glaze, Sec. 6-2s-3e. Drlg. sh. 8,326 ft.
Amerada Pet. Corp.'s No. 3 Irion, Sec. 6-2s-3e. R.U.
Amerada Pet. Corp.'s No. 7 Marchive, Sec. 6-2s-3e. Drlg. sh. 1,448 ft.
Amerada Pet. Corp.'s No. 8 Marchive. Sec. 6-2s-3e. T.D. 8,580 ft.; 5½-in. csg. 8,579 ft.; perf. csg. 8,503-45 ft.; I.P. 617 B.P.D.; ¼-in. ck.
Amerada Pet. Corp.'s No. 1 White et al, Sec. 7-2s-3e. Drlg. sh. 7,196 ft.
W. C. Feazel et al's No. 1 R. Z. Sclater, Sec. 1-2s-2e. R.U.
G. W. Kenedy's No. 1 R. R. Irion, Sec. 1-2s-2e. Drlg. sh. 1,830 ft.
S. W. Richardson's No. 1-A Haas, Sec. 11-2s-2e. Drlg. sh. 6,730 ft.
S. W. Richardson's No. 7 Haas Inv. Co., Sec. 7-2s-3e. Drlg. sh. 3,026 ft.
Sun Oil Co.'s No. 2 Townsend, Sec. 8-2s 3e. R.U.

**Fausse Point—Iberia Parish**

Texas Co.'s No. 6 State, Twp. 11s-8e. 13⅜-in. csg. 1,407 ft.; cg. 5,170 ft.

**Gordon Island—Plaquemines Parish**

Texas Co.'s No. 37 State, Garden Island, Sec. 38-23s-33e. T.D. 5,795 ft.; 7-in. csg. 5,784 ft.
Texas Co.'s No. 39 State, Sec. 38-23s-33e. Drlg. sh. 1,320 ft.

**Golden Meadow—La Fourche Parish**

Acadian Prod. Co.'s No. 1 Dr. L. P. LeBlanc, Sec. 2-19s-22e. Drlg. sh. 2,630 ft.
Bateman Drlg. Co.'s No. 1 Harry Louviere, Sec. 9-19s-22e. R.U.
Bennett Oil Co.'s No. 3 Cheramie, Sec. 12-19s-22e. R.U.
Berkshire Oil Co.'s No. 6 Nicol, Sec. 2-19s-22e. T.D. 5,230 ft.; 5½-in. csg. 5,230 ft.
Berkshire Oil Co.'s No. 7 Nicol, Sec. 9-19s-22e. T.D. 2,670 ft.; 7-in. csg. 2,670 ft.
Berkshire Oil Co.'s No. 8 Nicol, Sec. 9-19s-22e. Drlg.
Boller & Rutledge's No. 1 Burger Cheramie, Sec. 12-19s-22e. 10¾-in. csg. 803 ft.; drlg. sh. 3,650 ft.
Brown & Woods' No. 1 S. Hogan, Sec. 9-19s-22e. T.D. 2,710 ft.; P.B. to 1,500 ft.; sdtrkd.; drlg. sh. 1,462 ft.
Peter Cloban's No. 1 Nat Alario, Sec. 2-19s-22e. R.U.
Golden Meadows Oil Co.'s No. 1 Whitney Rebstock, Sec. 2-19s-22e. Drlg.
Wm. Helis' No. 3 Gaspard, Sec. 9-19s-22e. R.U.
Jim McMurrey's No. 1 P. Collins, Sec. 12-19s-22e. Drlg.
M. H. Marr and R. A. Bristol No. 1 Church property, Sec. 2-19s-22e. T.D. 7,724 ft.; sdtrkd.; T.D. 9,007 ft.; P.B. and sdtrkd.; T.D. 2,652 ft.; T. sd. 2,647 ft.; 7-in csg. 2,647 ft.; tstd. S.W. and oil; P.B. 2,000 ft.; sdtrkd.; T.D. 2,666 ft.; T.S 2,648 ft.; flwd. oil and S.W.; perf. csg. 2,647-64 ft.; flwd. gas and S.W.; went dead; T.A.
Martex Oil Co.'s No. 1 Rebstock, Sec. 2-19s-22e. Loc.
M. H. Marr & Vaughn's No. 2 Adam Terrebonne, Sec. 9-19s-22e. Drlg. sh. 2,433 ft.
S. Rhodes Drlg. Co.'s No. 1 Falgout Holding Co., Sec. 12-19s-22e. Drlg. sd. &sh. 4,860 ft.
S. Rhodes Drlg. Co.'s No. 2 Falgout Holding Co., Sec. 9-19s-22e. Abd. loc.
St. Mary Oil Co.'s No. 1 Williams, Sec. 12-19s-22e. T.D. 5,491 ft.; rmg.
Terouche Oil Co.'s No. 2 Cheramie, Sec. 12-19s-22e. Drlg.
Texas Co.'s No. 4 Falgout Holding Co., Sec. 9-19s-22e. Loc.
Texas Co.'s No. 5 Falgout Holding Co., Sec. 9-19s-22e. Drlg. sh. 1,310 ft.
Texas Co.'s No. 4 L.L.&E., Golden Meadow, Sec. 78-19s-22e. Drlg. sdy. L. 4,669 ft.
Texas Co.'s No. 6 L.L.&E.-Golden Meadows, Sec. 78-19s-21e. 10¾-in. csg. 573 ft.; drlg. sdy. sh. 3,620 ft.
Texas Co. No. 3 State-Catfish Lake, Sec. 76-19s-21e. T.D. 3,509 ft.; 7-in. csg. 2,805 ft.; perf. csg. 2,740-62 ft.; W.O. S.R.
Texas Co. No. 1 Theriot, Sec. 12-19s-21e. T.D. 10,100 ft.; 7-in. csg. on bttm.; perf. csg. 7,190-7,210 ft.; tstd. S.W.; perf. csg. 6,602-07 ft.; I.P. 260 B.P.D.; ¼-in. ck.

**Grand Bay—Plaquemines Parish**

Gulf Oil Corp.'s No. 5-A Grand Prairie, Sec. 31-19s-19e. Drlg. sdy. sh. 7,885 ft.
Gulf Oil Corp. No. 6-A Grand Prairie Lv. Dist., Sec. 17-20s-10e. Drlg. sdy. sh. 9,801 ft.
Gulf Oil Corp.'s No. 7-A Grand Prairie Lv. Dist., Sec. 5-20s-19e. Loc.
Gulf Oil Corp.'s No. 8-A Grand Prairie Dist., Sec. 5-20s-19e. Loc.
Gulf Oil Corp.'s No. 4 State, Sec. 20-19s-19e. Loc.
Texas Co. No. 1 State-Lookout Pass, Sec. 48-20s-18e. Loc.

**Grand Lake—Cameron Parish**

Amerada Pet. Corp.'s No. 2 Mallard Bay, Twp. 15s-4w. 10¾-in. csg. 1,317 ft.; drlg. sh. 1,821 ft.
Superior Oil Co.'s No. 4 Grand Lake, Twp. 13s-4w. Drlg. sh. 6,212 ft.

**Hackberry—Cameron Parish**

Gulf Oil Corp. No. 25-A Erwin, Sec. 18-12s-10w. Drlg.
Stanolind O. & G. Co.'s No. 20 Cameron Par. Sch. Ld., Sec. 16-12s-10w. T.D. 1,454 ft.; fsg.
Stanolind O. & G. Co.'s No. 30-B Gulf Ld., Sec. 31-12s-10w. Drlg. sd.&sh. 6,817 ft.
Superior Oil Co.'s No. 7 Benson Vincent, Sec. 30-12s-10w. T.D. 7,733 ft.
Texas Co. No. 27-B State, 623 ft. S, and 5,142 ft. E of SE cor. Sec. 12-12s-10e in Twp. 12s-9w. T.D. 7,843 ft., salt; T. salt 7,839 ft.; P.B. 6,500 ft.; sdtkd.; T.D. 7,973 ft.; abd.
Union Sulphur Co.'s No. 1 Simon Doiron Sec. 37-12s-10w. Drlg. sdy. sh. 6,596 ft.

**Horseshoe Bayou—St. Mary Parish**

Texas Co.'s No. 3 State, Sec. 40-17s-9e T. sd. 11,311 ft.; cg. sd. S.O.&G. 11,323 ft.

**Jeanerette—St. Mary Parish**

Continental Oil Co.'s No. 1 Leon De Mary, Sec. 17-12s-3e. Loc.
Herton Oil Co.'s No. 8 Roane, Sec. 38-13s-9e. Drlg. sh. 7,420 ft.

**Jefferson Island—Iberia Parish**

Texas Co.'s No. 3 Jefferson Salt Mining Co., Sec. 58-12s-5e. T.D. 7,914 ft.; 7⅝-in. csg. 7,802 ft.

**Jennings—Acadia Parish**

Carter-Perrin & Brian No. 1 Martel, Sec. 47-9s-2w. T.D. 1,916 ft.; 6-in. csg. 1,862 ft.; abd.
Glassell-Glassell No. 8 Trusher, Sec. 42-9s-2w. Drlg. sdy. sh. 7,912 ft.
Gulf Oil Corp.'s No. 42 Arnaudet, Sec. 47-9s-2w. Drlg. sh. 3,476 ft.
Shell Oil Co., Inc.'s No. 8 Community. T.D. 6,042 ft.; rmg.
Stanolind O. & G. Co. No. 115 Crowley Oil & Min. Co., Sec. 48-9s-2w. T.D. 7,639 ft.; 5-in. csg. 7,624 ft.; perf. csg. 7,550-75 ft.; I.P. 178 bbl. in 9 hrs.; ¼-in. ck.

**Lafitte—Jefferson Parish**

Texas Co. No. 14 Lafitte, Sec. 20-17s-24e T.D. 4,599 ft.; P.B. 3,404 ft.; sdtrkd.; drlg. sdy. sh. 4,077 ft.
Texas Co.'s No. 4 Marrero, Sec. 21-17s-24e. Drlg. sh.&L. 6,856 ft.

**Lake Long—La Fourche Parish**

Fohs Oil Co.'s No. 11 State, Twp. 17s-19e 10¾-in. csg. 2,034 ft.; cg. sh. 9,340 ft.

**Lake Mongoulois—St. Martin Parish**

Texas Co. No. 7 State, Sec. 10-10s-7e 7⅝-in. csg. 10,604 ft.; T.D. 10,775 ft.; perf. csg. 10,220-40 ft.; testd. gas; sqzd. perf.; perf. csg. 9,739-49 ft.; tstd. 3,000 lb. W.P.; perf. csg. 9,570-85 ft.; tstd. S.W.; perf. csg. 9,502-20 ft.; tstd. dry gas; perf. csg. 8,909-48 ft.; tstd. S.W.; flwg. gas and dist.

**Lake Pelto—Terrebonne Parish**

Texas Co.'s No. 28 State, Sec. 7-23s-18e. Drlg. sdy. sh. 4,810 ft.

**La Pice—St. James Parish**

Shell Oil Co., Inc.'s No. 1 Lebermuth & Israel. Cg. sdy. L. 9,143 ft.
Shell Oil Co., Inc.'s No. 2 Natalbany Lbr. Co., Sec. 19-9s-2e. Cg. sh. S.O. 9,150 ft.

**Leeville—Plaquemines Parish**

Texas Co.'s No. 72 L.L.&E., Sec. 27-21s-22e. T.D. 5,041 ft.; sdtrkd.; T. salt 6,854 ft.; T.D. 6,866 ft.

**New Iberia—Iberia Parish**

Wm. Helis' No. 7 Sabatier, Sec. 54-12s-7e. 7-in. csg. 2,205 ft.; drlg. sd. 2,804 ft.
Wm. Helis No. 7 J. E. Schwing, Sec. 55-12s-7e. T.D. 8,850 ft.; P.B. 7,840 ft.; drlg. sd.&sh. 8,192 ft.
J. J. Hooper's No. 1 Marston, Sec. 51-12s-7e. S.D. 500 ft.
Texas Co. No. 2 Bryant, Sec. 25-12s-7e. R.U.
Texas Co.'s No. 11 J. P. Duhe, Sec. 28-12s-7e. T. salt 3,412 ft.; T.D. 3,415 ft.; P.B. 2,500 ft.; sdtrkd.; T.D. 3,777 ft.; 7-in. csg. 3,729 ft.; W.O.S.R.
Texas Co.'s No. 12 Duhe, Sec. 26-12s-7e. Drlg. sh. 3,536 ft.
Texas Co.'s No. 1 Polk Hebert, Sec. 25-12s-7e. Drlg. sh. 1,915 ft.
Texas Co.'s No. 3 Schwing, Sec. 71-12s-7e. Drlg. L. 7,883 ft.
Texas Co.'s No. 1 H. Perry Walet, Sec. 2-12s-7e. R.U.

**North Crowley—Acadia Parish**

Humble O. & R. Co.'s No. 5 Habetz, Sec. 45-8s-1e. Drlg. sh. 7,011 ft.
Humble O. & R. Co.'s No. 6 Ohlenforst, Sec. 34-8s-1e. Loc.

**North Elton—Allen Parish**

Stanolind O. & G. Co.'s No. 1 G. W. Jenkins, Sec. 23-6s-3w. Drlg. sh. 6,175 ft.

**Paradis—St. Charles Parish**

Texas Co. No. 2 L.L.&E. Paradis, Sec. 6-14s-20e. Cd. sd., dist. odor 10,085-89 ft.; 7-in. csg. 10,497 ft.; drlg. sh. 10,770 ft.

**Plumb Bob—St. Martin Parish**

Texas Co.'s No. 13 St. Martin Ld. Co., Sec. 21-8s-7e. Dredge canal.

**Port Barre—St. Landry Parish**

Gulf Oil Corp.'s No. 17 Wilson-Broach, Sec. 4-6s-5e. R.U.
McDannald Oil Co.'s No. 2 Tutral, Sec. 20-6s-5e. Loc.
Pan American Prod. Co.'s No. 4 Cormier, Sec. 4-6s-5e. T.D. 5,425 ft.; P.B.; sidetracked; drlg. sh. 4,390 ft.
Pan American Prod. Co.'s No. 5 Garland, Sec. 4-6s-5e. Drlg. sh.&sd. 3,596 ft.
V. D. Spill No. 1 Gaudet, Sec. 4-6s-5e S.D. 4,700 ft.

**Potash—Plaquemines Parish**

Humble O. & R. Co. No. 40 Orleans Lv Bd., Sec. 13-18s-15e. T.D. 6,191 ft.

**Quarantine Bay—Plaquemines Parish**

Gulf Oil Corp.'s No. 3-A Plaquemines Ld. Co., Sec. 7-19s-17e. Drlg. sdy. sh. 6,320 ft.
Gulf Oil Corp. No. 9 State QQ, Sec. 18-19s-17e. Loc.
Gulf Oil Corp.'s No. 15 State, Twp. 19s-17e. T.D. 7,721 ft.; T. sd. 7,693 ft.

**Sorrento—Ascension Parish**

Sorrento Synd. No. 1 L. L. Bernard Sec. 27-10s-4e. Drlg. sh. 7,467 ft.

**South Houma—Terrebonne Parish**

Shell Oil Co., Inc.'s No. 4 Peters, Sec 72-18s-18e. Drlg. sh.&L. 9,465 ft.

**South Jennings—Jeff Davis Parish**

Stanolind O. & G. Co.'s No. 1 Doherty, Sec. 15-10s-3w. Drlg. sh. 7,172 ft.

**Starks—Calcasieu Parish**

W. T. Burton's No. 1 Industrial Lbr. Co., Sec. 29-9s-1w. Drlg. sh. 5,190 ft.

**Valentine—La Fourche Parish**

Wm. Helis' No. 5 Valentine Sugars, Inc., Sec. 2-17s-20e. 10¾-in. csg. 1,632 ft.; T.D. 7,845 ft.; P.B. 6,965 ft.; 7-in. csg. 6,990 ft.
Pan American Prod. Co.'s No. 3-A Community, Sec. 10-17s-20e. Drlg. sd.&sh. 7,883 ft.

**Venice—Plaquemines Parish**

Tide Water Asso. Oil Co.'s No. 6 Buras Lv. Bd., Sec. 27-21s-30e. Drlg. sh. 10,179 ft.

**Villa Platte—Evangeline Parish**

Continental Oil Co.'s No. 2 Attales, Sec. 45-3s-2e. R.U.
Continental Oil Co. No. 2 Corell, Sec. 36-3s-2e. T.D. 10,360 ft.; 6-in. csg. 10,360 ft.; perf. csg. 10,230-45 ft.; tstd. S.W.; perf. csg. 10,180-90 ft.; I.P. 97 bbl. in 17 hrs.; ¼-in. ck.
Continental Oil Co.'s No. 4 A. M. Fontenot, Sec. 46-3s-2e. T.D. 9,030 ft.; 6-in. csg. on bttm.
Continental Oil Co.'s No. 5 Fontenot, Sec. 26-3s-2e. T.D. 9,057 ft.; tstg.
Continental Oil Co.'s No. 4 Hirsch, Sec. 44-3s-2e. Drlg. sh. 6,820 ft.
Continental Oil Co.'s No. 5 Opelousas, St. Landry, Sec. 44-3s-2e. Drlg. sh. 8,510 ft.
Continental Oil Co.'s No. 2 Phillip Fontenot, Sec. 44-3s-2e. R.U.
Continental Oil Co.'s No. 4 Pitre, Sec. 44-3s-2e. Cg. sd. 8,986 ft.
Continental Oil Co.'s No. 1 J. E. Vidrine, Sec. 41-4s-2e. Drlg. sh. 8,620 ft.
J. K. Hughes' No. 1 J. E. Ortego, Sec. 36-3s-2e. Cg. sdy. sh. 10,226 ft.; cd. sd. S.O.&G. 9,960-90 ft. and 10,122-60 ft.; T.D. 10,306 ft.; 5½-in. csg. 10,301 ft.

**West Lake Verret—St. Mary Parish**

Shell Oil Co., Inc.'s No. 4 Jeanerette. Loc.

**White Castle—Iberville Parish**

Shell Oil Co., Inc.'s No. 1 Baist. T.D. 6,108 ft.; fsg.

**Woodlawn—Jeff Davis Parish**

Union Sulphur Co. No. 1 Raymond Hebert, Sec. 6-9s-5w. 7-in. csg. 9,575 ft.; drlg. sh.&L. 9,615 ft.
Union Sulphur Co.'s No. 1 E. A. Norton, Sec. 12-9s-5w. Drlg. sh.&L. 6,160 ft.
Union Sulphur Co. No. 3 Mrs. O'Miller, Sec. 7-9s-5w. Drlg. sdy. sh. 7,635 ft.
Woodlawn Oil Corp.'s No. 1 Hebert, Sec. 1-9s-6w. Drlg. 6,312 ft.

## S. LOUISIANA WILDCATS

**Acadia Parish**

Tri Parish Drillers, Inc., No. 1 Paul Stag, Sec. 4-7s-1w. M.I. rig.

**Allen Parish**

Bel Oil Co. No. 2 J. A. Bell Est. (Blue Springs). Drlg.

**Assumption Parish**

Shell Oil Co., Inc.'s No. 1 C. S. Eellis. Sec. 9-16s-14e. Drlg. sh.&sd. 7,370 ft.

**Beauregard Parish**

Atlantic Ref. Co. No. 1 Lutcher Moore, Sec. 22-3s-11w. Loc.
Atlantic Ref. Co. No. 1 Rice Ld. & Lbr. Co., Sec. 22-3s-11w. Loc.
California Co.'s No. 2 Long Bell Lbr. Co., Sec. 12-5s-10w. Drlg. sh.&L. 9,430 ft.
Republic Prod. Co.'s No. 9 Lutcher Moore Lbr. Co., Sec. 1-7s-12w. Cg. 7,950 ft.

**Calcasieu Parish**

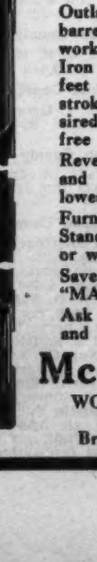
C. L. Arnette's No. 1 Arthur Welch, Sec. 19-10s-12w. 10¾-in. csg. 130 ft.; T.D. 395 ft.; S.D.
Gulf Oil Corp.'s No. 1 Amanda Brannon, Sec. 16-11s-10w. Cg. S.W. sd. 9,162 ft.

**Cameron Parish**

Humble O. & R. Co.'s No. 1 F. J. Pavell, Sec. 5-15s-14w. R.U.
Phillips Pet. Co.'s No. 1 Miami Corp., Sec. 11-14s-6w. R.U.

**East Baton Rouge Parish**

Farris & Golding Drlg. Co.'s No. 1 D. E.

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Outlasts three ordinary barrels, as Steel Plunger works in and out of Cast Iron Barrel as much as 2 feet on the up and down stroke and more if desired, thus flushing itself free of sand or gypsum.

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McEnnis, Sec. 58-7s-1e. 20-in. csg. 42 ft.; 10¾-in. csg. 1,747 ft.

**Iberia Parish**

Plymouth Oil Co. et al's No. 1 Lynch McHugh, Sec. 13-12s-10e. T.D. 720 ft.; recmtd. surf. csg.

**Jefferson Parish**

California Co. No. 1 Adam Rutley, Sec. 2-16s-23e. 20-in. csg. 163 ft.; 13⅜-in. csg. 1,980 ft.; 9⅝-in. csg. 8,496 ft.; T.D. 12,222 ft.; perf. csg. 8,204-14 ft.; I.P. 272 B.P.D.; ⅞-in. ck.; T.P. 1,360-1,400 lb.

Continental Oil Co. No. 1 Bernstein, Sec. 2-16s-23e. T.D. 10,436 ft.; may abd.

**Jeff Davis Parish**

Housh & Thompson's No. 1 Lacassine, Sec. 29-11s-5w. Cg. sh. 9,282 ft.

**Lafayette Parish**

Stanolind O. & G. Co.'s No. 1 Lacaze Billeaud et al, Sec. 35-10s-5e. Drlg. sh. 9,966 ft.

**La Fourche Parish**

Gulf Oil Corp. No. 2 Grandison, Sec. 21-20-23e. 13⅜-in. csg. 2,090 ft.; drlg. sh. 10,120 ft.

Tide Water Asso. Oil Co. No. 1 Delta Farms, Inc., Sec. 6-17s-23e. Drlg. sh 9,967 ft.

**Livingston Parish**

Humble O. & R. Co.'s No. 1 Great Southern Lbr. Co., Sec. 27-7s-5e. T.D. 9,371 ft.; abd.

**Orleans Parish**

W. T. Burton No. 1 L.&N.R.R., Sec. 18-11s-15e. T.D. 10,394 ft.; 5½-in. csg. 10,274 ft.; S.D.

**Plaquemines Parish**

Gulf Oil Corp.'s No. 1-D Buras Lv. Dist., Sec. 6-23s-31e. Dredge canal.

**St. Bernard Parish**

Gulf Ref. Co. No. 4-State-R.R. (Lake Borgne), Twp. 12s-15e. 9⅝-in. csg. 8,161 ft.; T.D. 10,632 ft.; P.B. 9,700 ft.; rmd. to 9,658 ft.; lost core bbl.; P.B. sdtrkd. 8,912 ft.; T.D. 10,528 ft.; 7-in. csg. 10,494 ft.; fsg.

**St. John the Baptist Parish**

Pan American Prod. Co. No. 1 Mill, Sec. 12-11s-7e (LaPlace prospect). 10¾-in. csg. 2,837 ft.; T.D. 8,896 ft.; D.S.T. 8,870-96 ft.; tstd. 600 lb. W.P.; rec. 10 gal. dist.; T.D. 10,175 ft.; P.B. 10,043 ft.; prep. to perf. csg.

**St. Martin Parish**

Wm. Helis' No. 2 Levert Plantation, Sec. 33-9s-7e. Drlg. limy sh. 5,664 ft.

Wm. Helis' No. 1 Rycade Oil Co., Sec. 33-9s-7e. Drlg. sh. 6,928 ft.

Shell Oil Co., Inc., No. 1 Iberville La. Co., Sec. 86-8s-7e. Cg. sh. 9,861 ft.

**St. Mary Parish**

Perry S. Cooney No. 1 A. W. Allain, Sec. 46-13s-9e. S.D. 2,600 ft.

Texas Co.'s No. 1 State West Cote Blanche Bay, Twp. 16s-7e. Loc.

**Terrebonne Parish**

Barnsdall Oil Co.'s No. 1 Nelson, Sec. 2-21s-11e. Loc.

Continental Oil Co. et al's No. 1 Peters, Sec. 32-19s-15e. 13⅜-in. csg. 1,987 ft.; drlg. sh. 9,820 ft.

Shell Oil Co., Inc., No. 1-A Peters, Sec. 47-19s-19e. T.D. 11,803 ft.; abd.

**Vermilion Parish**

La. Ld. & Explg. Co.'s No. 3 La. Fur Co., Sec. 9-15s-1e. Drlg. sh. 7,192 ft.

Texas Co.'s No. 1 Vermilion Par. Sch. Bd., Sec. 16-13s-4e. Drlg. sh. 3,070 ft.

# TEXAS

Week Ended November 11

## GULF COAST FIELDS

**Anchor—Brazoria County**

Humble O. & R. Co.'s No. 1 M. W. Mettler, J. de Jesus Valderas Sur. 13⅜-in. csg. 944 ft.; 9⅝-in. csg. 7,139 ft.; drlg. sd. 9,023 ft.

Glenn McCarthy's No. 1 Ida M. Salmon and John Muma, Geo. Robinson Sur. 9⅝-in. csg. 6,860 ft.; drlg. sh. 9,016 ft.

**Old Ocean—Brazoria County**

Harrison & Abercrombie No. 6 Armstrong-fee, Polly-Chance Sur. T.D. 10,421 ft.; tstg.

Harrison-Abercrombie's No. 7 Armstrong, Polly & Chance Sur. Drlg. sd. &sh. 10,020 ft.

Harrison & Abercrombie's No. 7 Bernard River Ld. Dev. Co., C. Breen Sur. Drlg. sh. 2,020 ft.

Harrison & Abercrombie's No. 1 Bertheisen, C. Breen Sur. Drlg. sh.&L. 9,612 ft.

Stanolind O. & G. Co.'s No. 1 Giles, C. Breen Sur. Loc.

Sun Oil Co.'s No. 3 Borsodi, C. Breen Sur. Spd.

Sun Oil Co.'s No. 3 Campbell, C. Breen Sur. 13⅜-in. csg. 1,506 ft.; 9⅝-in. csg. 7,008 ft.; drlg. sh.&L. 8,410 ft.

**Cedar Point—Chambers County**

Standard Oil Co. of Texas' No. 55-119 State. 10¾-in. csg. 1,607 ft.

**Seabreeze—Chambers County**

Sun Oil Co. No. 2 Hoffman, T.&N.O. Sur. No. 131. T.D. 8,400 ft.; W.O.C.

**Turtle Bay—Chambers County**

Stanolind O. & G. Co.'s No. 1 H. B. Amick, Shadrock Burney Sur. Drlg. sh. 4,056 ft.

Stanolind O. & G. Co.'s No. 2 State, Tr. 39. 16-in. csg. 115 ft.

**Garwood—Colorado County**

Davis & Co., Inc., No. 1 J. R. McLane, I.&G.N. Sur. 41. Drlg. sh. 9,448 ft.

**Big Creek—Fort Bend County**

Merrimac Oil Corp. No. 1 George, B. Wickson Sur. (SW flank). Spd. and S.D.

**Caplen—Galveston County**

Sun Oil Co.'s No. 3 Cade, A. Dickson Sur. 10¾-in. csg. 1,939 ft.; drlg. sh. &sd. 5,920 ft.

**League City—Galveston County**

Phillips Pet. Co.'s No. 1 Brittnacher, S. F. Austin Sur. Drlg. sh. 7,863 ft.

Phillips Pet. Co.'s No. 6 Lobit, Perry Austin Sur. Drlg. sh.&sd. 8,680 ft.

Phillips Pet. Co. No. 1 Dr. O. Patton (1 mi. E of production). Perf. csg. 9,177-97 ft.; flwd. S.W.; sqzd. perf.; C.O.

Phillips Pet. Co.'s No. 2 J. S. Rice est., J. M. Perry & Austin Sur. Cg. 8,865 ft.

Phillips Pet. Co.'s No. 3 Stewart Title Guaranty Co., S. F. Austin Sur. R.U.

Phillips Pet. Co.'s No. 4 Stewart Title Guaranty Co., S. F. Austin Sur. 10¾-in. csg. 3,520 ft.; drlg. sh. 9,538 ft.

Phillips Pet. Co. No. 1 Wimhurst (NW extension). T.D. 10,962 ft.; well tried to blow out; D.S. stk.; P.B. 10,630 ft.; perf. csg.; tstg.

**Bammel—Harris County**

H. M. Harrell's No. 1 Ehrhardt, Ehrhardt & Ketchum Sur. Loc.

H. M. Harrell's No. 1 Graves, C. Walters Sur. Loc.

**Clear Lake—Harris County**

Humble O. & R. Co.'s No. 22-C Humble-West, J. Roth Sur. T.D. 5,915 ft.; W.O.C.

Humble O. & R. Co.'s No. 6 Hutcheson, Wm. Dobie Sur. Drlg. sh. 2,910 ft.

**Friendswood—Harris County**

Humble O. & R. Co.'s No. 5 Owens, T. Choate Sur. Drlg. sh. 5,020 ft.

Humble O. & R. Co.'s No. 17 West Prod. Co., L. Hemenway Sur. Drlg. sh. 5,486 ft.

**Ganado—Jackson County**

Texas Co.'s No. 1 Ross, J. Simon Sur. Loc.

**Fannett—Jefferson County**

Gulf Oil Corp.'s No. 12 Burrell, W. H. Smith Sur. T.D. 3,625 ft.; D.S.T. 3,614-35 ft.; rec. 34 thrib. oil; 7-in. csg. 3,629 ft.; flwd. oil and S.W.; T.D. 4,303 ft.; 6-min. D.S.T. 4,286-4,303 ft. rec. 39 thrib. oil and sd.; W.O.

**La Belle—Jefferson County**

Sun Oil Co. No. 5 Broussard-Hebert, T.&N.O. Sur. No. 207. T.D. 8,710 ft. perf. csg. 8,685-90 ft.; flwd. S.W.; made sqze. job; perf. csg. 8,667-71 ft.; tstd. S.W.; made sqze. job; S.D.

**Lovells Lake—Jefferson County**

J. H. Blaffer's No. 1 Williams, Wm. Carr Sur. Spd.

Humble's No. 12 Broussard, M. Grange Sur. Drlg. L. 6,820 ft.

Humble O. & R. Co.'s No. 3-B Steinhagen, A. O. Donnell Sur. Drlg. sh. 4,096 ft.

Stanolind O. & G. Co.'s No. 2-B Steinhagen, H. O. Donnell Sur. Drlg. sh. 3,830 ft.

**South China—Jefferson County**

Hebert & Smith's No. 1 Guitermann, G. T. Gaylor Sur. 12. R.U.

**Esperson—Liberty County**

General Crude Oil Co.'s No. 7-B Esperson, A. McNeil Sur. Drlg. sh. 7,627 ft.

General Crude Oil Co.'s No. 9-B Esperson, A. McNeil Sur. Drlg. sh. 7,550 ft.

**Hull—Liberty County**

Gulf Oil Corp. No. 115 Phoenix Dev. Co., J. Devore Lge. (SE flank deep test). 9⅝-in. csg. 5,904 ft.; drlg. sh. 7,206 ft.

**Martha—Liberty County**

Pan American Prod. Co.'s No. 1 Hutcheson, Beasley Pruitt Sur. Drlg. 1,510 ft.

Stanolind O. & G. Co.'s No. 1 R. G. Palmer, I.&G.N. Sur. 7. Drlg. sh.&L. 4,036 ft.

Stanolind O. & G. Co.'s No. 2 Seaberg. Drlg. sh. 1,812 ft.

Stanolind O. & G. Co.'s No. 1 H. F. Tyrell, I.&G.N. Sur. 7. 10¾-in. csg. 1,214 ft.; drlg. sh.&L. 7,216 ft.

**Segno—Polk County**

J. K. Dorrance's No. 5-A Wing, I.&G.N. Sur. Drlg. 7,986 ft.

Gulf Oil Corp. No. 4 Quinn, A. Morales Sur. R.U.

Gulf Oil Corp.'s No. 25 Wing, I.&G.N. Sur. 15. Drlg. sh. 2,030 ft.

Gulf Oil Corp.'s No. 26 Wing, I.&G.N. Sur. 15. Drlg. sdy. sh. 4,026 ft.

Humble O. & R. Co.'s No. 18 BX Kirby Lbr. Co., P. Garcia Sur. Drlg. sh. 7,610 ft.

Jordan Drlg. Co.'s No. 1 E. H. Hughes, I.&G.N. Sur., Sec. 13. Drlg. sh. 5,274 ft.

**Spurger—Tyler County**

Republic Prod. Co.'s No. 28 fee, N. Hurd Sur. R.U.

Republic Prod. Co.'s No. 29 fee, N. Hurd Sur. R.U.

## GULF COAST WILDCATS

**Brazoria County**

Fabriguze et al No. 1 Freeport Sulphur, Stephen F. Austin Sur. (Byran Mound) M.L.M.

Hamman Expltn. Co. No. 1-B Darrington, State Prison Farm, F. Bingham Sur. Rig.

D. M. Hill's No. 1 Max Bader, Wm. Smeathers Lge. Loc.

Humble O. & R. Co.'s No. 1 Hiram Moore, Hooper & Wade Sur., Lot 27. 10¾-in. csg. 2,477 ft.

Humble O. & R. Co.'s No. 1 A. M. Smith, W. D. C. Hall Sur. Drlg. sh. 5,312 ft.

Glenn McCarthy's No. 1 E. W. K. Andrau, H.T.&B. Sur. 5. 10¾-in. csg. 3,512 ft.; drlg. sh. 7,049 ft.

Glenn McCarthy's No. 2 Houston Farm Dev. Co., J. Perry & E. Austin Sur. 7. 10¾-in. csg. 3,492 ft.; drlg. sh. 7,365 ft.

Mayo & Frazier's No. 1 Darrington, State Prison Farm, A. McFarlan Sur. R.U.

Texas Co.'s No. 8 Freeport Sulphur Co., Ariola Sur. Drlg. sh. 996 ft.

Titanic Oil Co.'s No. 1 Allen, J. G. and G. W. McNeel Lge. (Allen dome). Top hvng. sh. 4,830 ft.; drlg. sh. 5,237 ft.

**Chambers County**

Geo. Anderson No. 1 Julia Casey, W. D. Smith Sur. Loc.

J. R. Turnbull's No. 1 Kirby Lbr. Co., Chambers Co. Sch. Ld. Attempted D.S.T. 6,419-31 ft.; seat failed to hold; T.D. 6,431 ft.; 7-in. csg. 6,420 ft.; I.P. 79 B.P.D.; ⅞-in. ck.; T.P. 150 lb.; C.P. 1,100 lb.

J. R. Turnbull et al No. 1 W. C. Shepherd, R. A. Porter Sur. T.D. 6,466 ft.; 7-in. csg. 6,429 ft.; flwd. oil, gas, and wash wtr.; sanded up; sdtrkd. 6,463 ft.; T.D. 6,700 ft.; P.B.; perf. 6,457-65 ft.; S.D.

**Colorado County**

Cockburn Oil Corp. No. 1 R. W. Ferra H. Chrisman Sur. Loc.

**Fort Bend County**

H. C. Cockburn's No. 1 G. W. Burkett, Bundieck Sur. Loc.

Gulf Oil Corp.'s No. 1 Russell Brown, Wm. Pettus Sur. 10¾-in. csg. 1,228 ft. drlg. sh.&L. 4,740 ft.

H. Link & J. Mayo's No. 1 R. G. Foss, Sec. 63, H.&T.C. Sur. R.U.

Magnolia Pet. Co.'s No. 1 G. H. Huntington, Henry Scott Sur. Drlg. sh. 6,825 ft.

Superior Oil Co.'s No. 1 A. P. George, Wiley Martin Sur. R.U.

**Galveston County**

Hebert & Smith's No. 1 J. A. Harris, Edw. Hall & Levi Jones Sur. Loc.

Sun Oil Co.'s No. 1-176 State. T.D. 8,044 ft.; well tried to blow out; S.D.; may run csg.

**Grimes County**

Roan, Coker & Kile's No. 1 W. W. Greer, Patrick B. O'Connor Sur. 10¾-in. csg. 41 ft.; T.D. 2,825 ft.; abd.

**Harris County**

Temple Hargrave's No. 1 Herman Hospital, Wm. Hardin Sur. T.D. 7,512 ft.; abd.

McDannald Oil Co.'s No. 1 C. Brown, H. T.&B. Sur. 7. T.D. 8,012 ft.; abd.

Dick Schwab et al's No. 1 Abe Gordon, M. Woods Sur. Drlg. 1,134 ft.

L. R. Wilhite et al No. 1 Houston-Harris Co. Ship Channel, Nav. dist., Ezekiel Thomas Sur. 13-in. csg. 388 ft.; drlg. 4,620 ft.

**Jefferson County**

I. E. Harwell No. 1 State, Gulf of Mexico. T.D. 5,840 ft.; D.S. stk.; pulled in two; S.D.

**Matagorda County**

Gulf Stream Oil Co.'s No. 1 G. W. Ziprian, Luke Lessassier Sur. Spd.

McDannald Oil Co.'s No. 1 J. L. Woodhouse, Lewis De Moss Sur. Drlg. sh. 3,325 ft.

Van M. Vincent's No. 1 J. F. McNabb Est., E. R. Wightman Lge. Loc.

**Montgomery County**

David B. MacDaniel's No. 1 Hattie O. Baldwin, Walker Co. Sch. Ld. Sur. 10¾-in. csg. 1,230 ft.; drlg. sh. 5,060 ft.; est. tight well.

T. J. Wood & J. R. Martin's No. 1 H. B. Fultz, Wm. C. Clark Sur. R.U.

**Newton County**

W. M. Oil Co.'s No. 1 W. A. Smith, Tex Central R. R. Co., Sur. 2. R.U.

**Orange County**

American Eagle Oil Co. No. 2 Geo. Pell Geo. A. Patillo Sur. T.A. loc.

**Polk County**

Patrick-Tyrell Drlg. Co. No. 1 O. L. Jackson, C. Devore Sur. T.A. loc.

**San Jacinto County**

F. J. Hynes No. 1 Foster Lbr. Co., M. Brown Sur. T.A. loc.

F. J. Hynes No. 2 Foster Lbr. Co., M. Finch Sur. T.A. loc.

**Tyler County**

Oil Equity Corp.'s No. 2 Kountz, E. Smith Sur. T.A. loc.

**Washington County**

Mount Selman Oil Co. No. 1 Fritz Fuelberg, W. Lightfoot Sur. Drlg. sh. 2,924 ft.

Sunray Oil Co.'s No. 1 S. E. Lockhart, Gibson Kuykendall Sur. 10¾-in. csg. 1,192 ft.; drlg. sh. 4,060 ft.

**Wharton County**

Sam G. Harris et al's No. 1 C. T. Kountz, A.T.R.R. Sur., Sec. 51. T.D. 5,510 ft.; abd.

Houston Oil Co.'s No. 1 H. W. Hinze, Robt. Kuykendall Sur. (Spanish Camp area). Cg. 2,926 ft.

Humble O. & R. Co.'s No. 1 L. B. Henry, Napoleon B. Williams Sur. Drlg. sh. 2,465 ft.

J. F. Hutchins' No. 1 A. P. Borden, Euclid M. Cox Sur. Drlg. sh. 5,110 ft.

Dr. T. M. Neal No. 1 fee, Elisha Flack Sur. Loc.

Sun Oil Co.'s No. 1 Winnie M. Pool, G. H.&R.R. Sur. S.D. 7,348 ft.

## S. W. TEXAS WILDCATS

**Aransas County**

Continental Oil Co.'s No. 1 St. Charles Co., R. D. Blassman Sur. 18⅝-in. csg. 290 ft.; T.D. 8,384 ft.; fsg.

**Bastrop County**

C. R. Franklin's No. 1 Oscar McDonald, Martha Barker Sur. Drk.

Marts & Beaven's No. 1 J. E. Ferguson, Jas. Doyle Sur. S.D. 1,725 ft.

**Bee County**

Coronado Corp.'s No. 1 Claude Heard, M.M.&J. Tool Sur. 4-min. D.S.T. 3,257-70 ft. tstd. 320 lb. W.P.; cg. ahead.

Mills Bennett Prod. Co.-Anderson-Prichard Oil Corp.'s No. 1 D. E. Robinson, J. M. Uranga Sur. T. Wlx. sd. est. 7,531 ft.; cd. sd.&sh. good O.&G. odor; 14-min. D.S.T. 7,541-51 ft. rec. 15 ft. oil; 245 lb. W.P.; will core 10 ft. and make D.S.T.; 5-min. D.S.T. 7,620-60 ft. tstd. 62 lb. W.P.; rec. 225 ft. gas-cut mud; fsg.

**Bell County**

G. P. Shelton et al No. 1 Nelson, Michael Griffin Sur. S.D. 1,208 ft.

**Bexar County**

Heller Pet. Co.'s No. 1 Wildmann, Juan Sanchez Sur. 34. R.U.

J. A. Tarver's No. 1 Florence Lam, Manuel de Luna Sur. 3. 6⅝-in. csg. 1,205 ft.; T.D. 1,692 ft.; cd. blkn. sh. 1,638-92 ft.; S.S.O.; tstg.

**Blanco County**

E. L. Nixon's No. 3 Crist, John McClenechen Sur. 94. S.D. 536 ft.

**Brooks County**

Magnolia Pet. Co.'s No. 1 Vivian Rust, La Gloria townsite subd. Drlg. sd. 6,353 ft.

**Burleson County**

H. Y. Barnett's No. 1 Giesenschlag, J. W. Hollingsworth Sur. Loc.

**Caldwell County**

Dr. J. F. Atha's No. 1 G. W. Carter, Gideon Pace Sur. T.D. 1,793 ft.; 7-in. csg. 1,744 ft.; pmpg. an avg. 4 B.P.D. reacd.; tstg.

Kean & Williamson's No. 1 E. E. Rector, J. Roberts Sur. Drlg. 310 ft.

**Calhoun County**

Continental Oil Co.'s No. 1 Powderhorn Co., Juan Cano Sur., Sec. 2, Blk. J. Drlg. sh. 2,930 ft.

Coronado Corp. No. 1 K. Welder, Hidalgo Sur., 3 mi. SE Seadrift. T.D. est. 8,310 ft.; S.D.; no report; "tight well."

**De Witt County**

Atlantic Ref. Co.'s No. 1 Pearl Conwell, Chas. Lockhart Sur. Loc.

Marshall Purvis No. 1 Afflerback, L. W. Criswell Sur. Drlg. sdy. sh. 7,421 ft.

**Duval County**

J. B. Blanchard et al's No. 1 J. G. Lowe, J. G. Love Sur. T.D. 3,502 ft.; abd.

J. B. Blanchard's No. 1 E. A. Parr, T. C. Rogers Sur. Loc.

W. L. Catlin et al No. 1 Louis Escapule J. Poitevent Sur. No. 73. Loc.

Frank Gravis' No. 1 F. Vaello, Robt. Fletcher Sur. Loc.

Magnolia Pet. Co.'s No. 1 D.C.R.C. Urbano Suarez Sur. 300. T.D. 2,130 ft.; abd.

Magnolia Pet. Co.'s No. 1 A. Well, C.& M.R.R. Sur. 113. T.D. 2,806 ft.; 7-in. csg. 2,789 ft.

Mills Bennett Prod. Co. and Stanolind O. & G. Co.'s No. 2-A Ira Yates, E. N. Gray Sur. 224. Loc.

Rowan & Hope's No. 1 Lopez, M. Lopez Sur. Loc.

Standard Oil Co. of Texas' No. 1 Jack Casey, San Pedro de Charco Redondo gr. T.D. 6,746 ft.; 7-in. csg. to test 6,722 ft.; perf. csg. 5,334-45 ft.; tstd. gas and dist.; S.I.

Taylor Ref. Co.'s No. 1 Parr, E. Garcia Sur. Loc.

**Falls County**

J. Shaunfield No. 1 Barganier, J. M. Graham Sur. T.D. 1,195 ft.; Buda L.; S.S.O.; waiting on csg.

**Gonzales County**

Continental Oil Co.'s No. 1, J. J. Garlin Sur. Drlg. sh. 2,250 ft.

J. A. Walker et al's No. 1 C. L. Dubose, E. C. Coffman Sur. Drlg. 490 ft.

**Guadalupe County**

Pat Armstrong's No. 1 Ernst Saetl, J. D. Clement Sur. Drlg. sh. 1,409 ft.

Burton-Garvin & Womack's No. 2 Henry Weil, E. de Los Santos Coy Sur. No. 93, R.U.

Knute Evjen et al's No. 1 W. C. Brawner, J. D. Pickens Sur. Drlg. sh. 2,092 ft.

F. D. Spratt's No. 1 Wm. Zuchl, Claiborne Rector Sur. 38. Drlg. 138 ft.

E. A. Weyel et al's No. 2 Bertha Schaffl, Vicente Mitchell Sur. 52. T.D. 838 ft.; abd.

E. A. Weyel's No. 3 Schaffl K. Bingham Sur. 487. R.U.

**Jim Hogg County**

W. C. Gray et al's No. 1 Rosa Palacios, G. W. Waddell Sur. S.D. 50 ft.

Humble O. & R. Co.'s No. 2 Mestena O. & G. Co., Francisco gr. Drlg. sh. 4,724 ft.

Mayfair Oil Corp.'s No. 1 I. R. Gutierrez, C. Gutierrez Sur. 164. T.D. 3,223 ft.; tstg.; 5½-in. csg. 3,217 ft.

C. A. Nibert et al's No. 1 Yeager Sur. 20. S.D. 1,316 ft.

**Jim Wells County**

Austin Pet. Co. No. 1 H. M. Reed (8 mi. NW Orange Grove), J. Poftevent Sur. Cmtd. surf. pipe 190 ft.; S.D. 210 ft.

Rodney DeLange et al's No. 1 Maggie McNeill, Benito Lopez de Jean gr. Tstd. 450 lb. pres.; D.S.T. 4,762-80 ft.; T.D. 5,410 ft.; 5½-in. csg. 4,880 ft.; perf. csg. 4,786-90 ft.; flwd. 63 bbl. dist.; 20 hrs.; 7/64-in. ck.; T.P. 1,750 lb.; C.P. 1,900 lb.; S.I.; sqzd. per.; re-perf. csg. 4,788-91 ft.; flwg. approx. 10 bbl. dist. per day; ¼-in. ck.; T.P. 1,775 lb.; C.P. 1,825 lb.; S.I.

H. H. Howell et al's No. 1 N. Hinojosa. S.K.&K. Sur., Sec. 229. Drlg. sh. 5,320 ft.

Magnolia Pet. Co.'s No. 1 C. C. Hornsby, Los Olmos y Loma Blanca gr. T.D. 6,435 ft.; D.S. stk.; fsg.

Magnolia Pet. Co.'s No. 1 W. C. Hornsby (La Gloria field). Drlg. sh. 6,020 ft.

Magnolia Pet. Co.'s No. 1 E. H. Stolze et al, Los Olmos y Loma Blanca gr. Lot 16, Blk. 10. Cd. sd.&sh. dist. odor 6,586-6,637 ft.; cg. 7,039 ft.

A. F. Sears & A. E. McKenzie's No. 1 J. H. McGahee. Loc.

Trinity Drillers et al's No. 1 Temple Lbr. Co., Los Presenos de Arriba gr. Cg. sh. 4,728 ft.

**Karnes County**

Clyde Eckols' No. 1 J. M. Newberry, Carlos Martinez Sur. Drlg. sh. 1,220 ft.

**Kendall County**

C. M. Dewey's No. 2 Seidensticker, R. Davis Sur. No. 20. S.D. 714 ft.

**Kimble County**

A. L. Bierschwale's No. 1 F. W. Kraeke, Sur. 366. S.D. 424 ft.

C. H. Wolff & M. C. Moore No. 1 W. J. Wilkinson, Brook & Burleson Sur., Sec. 24. S.D. 20 ft.

**Kleberg County**

Humble O. & R. Co.'s No. 1 H. Andrews, Rincon De Santa Gertrudis gr. Loc.

Humble O. & R. Co.'s No. 1 J. M. Reed, Rincon De Santa Gertrudis gr. Drlg. sh. 5,396 ft.

Pure Oil Co.'s No. 1 State, Tr. 171 (Bird Island field). T.D. 8,400 ft.; abd.

**La Salle County**

John Vivian's No. 1 Louis Yeager, A.B. &M. Sur. 53. T.D. 976 ft.; cd. O.S. 966-76 ft.; run csg.

**Lee County**

Fred Pederson et al No. 1 Brown, David Hudson Sur. Drlg. L. 6,751 ft.

**Live Oak County**

Loma Oil Co.'s No. 1 Vernor, John Turner Sur. 71. R.U.

A. R. Pohler's No. 1 A. J. Turner, Stephen Hays Sur. T.D. 899 ft.; 5½-in. csg. 890 ft.

L. W. Stieren's No. 3 Lange, Thos. Adams Sur. T.D. 1,497 ft.

**McMullen County**

J. C. Carter's No. 1 Thomas Franklin, E. L. Taylor Sur. 30. Loc.

Harrison & Ross' No. 1 T. A. Bracken, W. W. Allsberry Sur. 30. Cg. 986 ft.

Earl W. Rowe's No. 1 M. H. Reed, Seale & Morris Sur. 153. Cg. 1,412 ft.

C. D. Scarborough No. 1 First Natl. Bk. of Rosebud, Jas. Garner Sur. S.D. 1,515 ft.

J. A. Walton's No. 1 E. H. Chylek, J. M. Hernandez Sur. 962. Cg. 619 ft.

Wellington Oil Co.'s No. 1 Sam Sanger, C. P. Smith Sur. 194. T.D. 2,950 ft.; abd.

**Medina County**

Elstone Oil Co.'s No. 1 Wm. Mann, J. Campbell Sur. 24. 8¼-in. csg. 635 ft., 7-in. csg. 1,025 ft.; drlg. 1,506 ft.

**Milam County**

W. H. Lawrence et al's No. 1 J. F. Bartek, Jose De Pena. Sur S.D. 1,210 ft.

Taylor Ref. Co.'s No. 1 Lora Sheppard, Jose Justo Liendo Sur. Drlg. 783 ft.

**Nueces County**

John Manley et al No. 1 Ruegg, Geo. H. Pauls subd. of Driscoll ranch. Loc.

Fred Shields' No. 1 J. H. McElroy, M. L. De Herrera gr. Loc.

Stanolind O. & G. Co.'s No. 1 Jennie Thompson, J. V. L. de Herrera gr. (Riverside field). Cd. sd. sec. 4,878-4,919 ft.; T.D. 5,280 ft.; cmtd. csg. to test; perf. csg. 4,900-01 ft.; flwd. gas, dist., and S.W.; ½-in. ck.; T.P. 800 lb.; C.P. 1,500 lb.; S.I.

**Refugio County**

Hewitt & Daugherty's No. 3-A Rooke-Wagner, Jose Miguel Aldrete 4 Lge. and 1 Lge. gt. T.D. 6,520 ft.; abd.

Morgan Gulf Oil Corp.'s No. 1 J. M. Thomas, G. E. Coblan and Family Sur. T.D. 6,510 ft.; perf. csg. 6,250-57 ft.; jetted 52 B.P.D.

Norsworthy Prod. Co. No. 1 Wood, John Sinnott Sur. T.D. 6,508 ft. (cor.); S.D.

**Starr County**

Clopton, Mitchell et al's No. 1 F. W. Seabury, J. A. Falcon, Porc. 80. 8¼-in. csg. 88 ft.; drlg. sh. 1,585 ft.

H. L. Curry et al's No. 2 Tijerina, H.E. &W.T.R.R. Sur. 299. Drlg. shls. 630 ft.

C. L. Foster's No. 1 H. Garza, Juan Salinas, Porc. No. 71. S.D. 100 ft.

W. E. Gilbert's No. 1 Escobas, Jose F. Garza, Porc. 71. Drlg. 240 ft.

Lynes & Robertson's No. 1 Villareal, C. C.S.D.&R.G.N.G.R.R. Sur. 241. Loc.

Magnolia Pet. Co.'s No. 2 Yzaquirre, La Sal Colorado gr. R.U.

**Victoria County**

Colton & Colton's No. 1 E. Terrell, A. Sideck Sur. Cg. 4,860 ft.

Houston Oil Co.'s No. 1 E. C. Dietzel, P. Gallardo Sur. T.D. 5,171 ft.; logged O.S. 4,828-38 ft.; P.B. 4,835 ft.; perf. csg. 4,826-29 ft. and 4,829-32½ ft.; comp for gas well; flwd. 60 B.P.D.; 7/32-in. ck.; T.P. 1,590 lb.

Renwar Oil Corp.'s No. 1 M. L. Stoner, Diego Garcia Sur. Cg. 4,780 ft.

Stewart Boyle's No. 1 Simon, Victoria Four Lge. T.D. 2,907 ft.; 5½-in. csg. 2,700 ft.

Wellington Oil Co. et al's No. 1 J. W. Boothe, T.&N.O. Sur., Blk. 1, Sec. 10. Drlg. sh. 8,732 ft.

**Webb County**

W. C. McBride, Inc.'s No. 1 Manuel Vela, C.C.S.D.&R.G.N.G. Sur. 265. T.D. 1,840 ft.; abd.

Mayfair Oil Corp.'s No. 3 Bruni, J. V. Borego gr. Drlg.

Tide Water Asso. Oil Co. No. 7 Bruni, Blk. 7, M. Arispe gr, (deep test Bruni field). Cg. 8,326 ft.

**Williamson County**

Brown-Gardner et al's No. 1 G. W. Griffin, Harrison Owens Sur. T.D. 2,219 ft.; abd.

Knisely, Aldridge, Cockburn's No. 1 D. M. Sloan, J. W. Baker Sur. 2. T.D. 1,073 ft.; abd.

H. C. Lefors' No. 1 H. J. Priesmeyer, Jehu Bevil Sur. 56. Drlg. sh. 563 ft.

Williams & Vick's No. 1 Mrs. Schram, Willis West Sur. Drlg. L. 1,415 ft.

**Zapata County**

J. P. Martin et al's No. 1 Serapio Vela, El Grullo gt. R.U.

Neilson & Wise's No. 1 Maryland Tr. Co., J. H. Vermilion Sur. 314. Drlg. 538 ft.

Transwestern Oil Co.'s No. 1-L Trevino, S.K.&K. Sur. 63. Drlg. 1,926 ft.

## WEST TEXAS WILDCATS

**Brewster County**

H. D. Wilcox's No. 2 Kokernot, Sec. 23, Blk. C, J. V. Massey Sur. S.D.O. 1,610 ft.

**Cochran County**

Atlantic Ref. Co.'s No. 1 Boyd, Labor 11, Lge. 56, Oldham C.S.L. W.O.C. 4,900 ft.; S.O.

Dean & Hyde's No. 1 Reed & Taylor, Sec. 21, Harrison & Brown Sur., SE of Duggan pool. R.U.T. 4,800 ft.

**Crane County**

Gulf Oil Corp. No. 5 M. B. McKnight Sec. 1, Blk. 21-B, P.S.L. Sur. Drlg. out 5,528 ft. to straighten hole.

Gulf Oil Corp.'s No. 12 Waddell, Sec. 30, Blk. 26-B, P.S.L. Sur. Rng. 12-in. 532 ft.

**Crockett County**

Kimberlin's No. 1 J. W. Robbins, Sec. 4 Blk. B, G.C.&S.F. Sur. Drlg. 1,122 ft.

Moore Bros.' No. 1 Henderson, Sec. 51, Blk. O.P., G.C.S.F. Sur. Drlg. 308 ft.

**Crosby County**

Gulf Oil Corp. No. 1-C Swenson, Sec. 95 Blk. 2, H.&G.N. Sur. Drlg. 8,210 ft.

**Dawson County**

Ray Albaugh's No. 1 Dewey Hogg (O. W.D.D.). S.D.R. 4,212 ft.

**Ector County**

I. T. I. O.'s No. 1-B Johnson, Sec. 39, Blk. 43, T.&P. Sur. S.S.O. 4,100-08 ft. and 4,132-38 ft.; P.B. 4,178 ft.; flwd. 142 B.O.P.D.

**Gaines County**

Stanolind O. & G. Co.'s No. 1 American Warehouse, Sec. 5, D.&W. Sur., offset to No. 1 Rayner, discovery well. Drlg. 3,500 ft.

Stanolind O. & G. Co.'s No. 1 T. S. Riley, Sec. 11, Blk. H, D.&W. Sur. Spdg.

**Hockley County**

Geo. P. Livermore's No. 1 R. D. Glimp, Sec. 8, Blk. X, P.S.L. Sur. R.U.R. 200 ft.

**Lynn County**

John L. Baldridge No. 1 Alma Lbr. Co., Sec. 151, H.E.W.T. Sur. Drld. out 3,570 ft.; S.D.O.

**Pecos County**

B. McCandless and General Crude Oil Co.'s No. 1 Virginia W. Crockett, Sec. 5, Blk. 110, T.C.R.R. Sur. Drlg. rathole.

Stanley Thompson No. 1 Elsinore Cattle Co., Sec. 54, Blk. D, G.C.&S.F. Sur. Drld. by 7,073 ft.; 500 ft. S.W. in hole; S.D.O. 7,342 ft.

Superior Oil Co. No. 1 V. W. Crockett-Continental Oil Co., Sec. 7, Blk. 110, T.C.R.R. Sur. C.&P.

H. C. Walker's No. 1 Alva Reed, Sec. 20, Blk. 10, H.&G.N. Sur. Loc.

**Reeves County**

T.A.T. Oil Co.'s No. 1 U. G. Orenderff, Sec. 10, Blk. 59, P.S.L. Sur. Drlg. 204 ft.

**Scurry County**

Coffield & Guthrie's No. 1 Reiter, Sec. 155, Blk. 97, A.&T.C. Sur. Drlg. 1,618 ft.

**Terrell County**

E. M. Thomasson No. 1 Bates, Sec. 31, Blk. 1, H.&G.N. Sur. S.D.O. 1,117 ft.

**Tom Green County**

Johnson's No. 2 Rape, Sec. 2, Blk. 18, H.&T.C. Sur. Loc.

Dan Short's No. 1 J. G. Davidson, NW part of Lovie P. Moore Sur.; 3,500-ft. test. U.R. 8-in. 2,500 ft.

**Ward County**

Gulf Oil Corp. No. 5 Wristen, Sec. 18, Blk. 5, H.&T.C. Sur.; scheduled Ordovician test. M.I.R. 2,885 ft.

Magnolia Pet. Co.'s No. 2-43 Sealy, Sec 43, Blk. F, G.M.M.B.&A. Sur. W.O. 2,952 ft., T.D.; making 69,000,000 cu. ft. gas; incr. amt. oil; prep. to D.D.

Merry Bros. & Perini's No. 1 Bird Hayes, Sec. 148, Blk. 34, H.&T.C. Sur. Spd. and S.D.

**Yoakum County**

Sloan & Zook and T. N. Sloan's No. 1 J. E. Fitzgerald, Sec. 22, Blk. D, Gibson Sur., extreme NE cor. of county. Drlg. 3,400 ft.

## TEXAS PANHANDLE

**Deaf Smith County**

Uscan No. 1 Farwell, Sec. 18, Blk. 8, X Sur. C.O. 5,650 ft.

**Hartley County**

Phillips Pet. Co. No. 1 W. K. Gordon Sec. 3, Blk. 44, H.&T.C. Sur. showed 34,300,000 cu. ft. gas below 3,415 ft.; P.B. for gas well 3,415 ft.; tstg.

**Lipscomb County**

Phil O'Neil's No. 1 Jacob Koch. NW¼ SW¼ Sec. 539, T.&T.C.R.R. Sur. S.D. 1,100 ft.

**Ochiltree County**

James R. Macon et al No. 1 W. R. Norris SW SE Sec. 212, Blk. 43, H.&T.C. Sur. Bailing rotary fluid preparatory to resuming drlg. with C.T.; T.D. 6,274 ft. prep. acd. and test sec. at 5,000 ft.; est. 6,000,000 cu. ft. gas on D.S.T.; tstg.

**Potter County**

Les Whitaker No. 1 D. Pavillard, Sec. 101, Blk. 2, A.B.&M. Sur. Fish out; S.D. 915 ft., csg.

**Sherman County**

Hary, Harrington & Marsh's No. 1 W. Freeman, Sec. 46, Blk. 2, G.H.&H. Sur. tstg. 20 mfg. prep. drill deeper.

I.T.I.O.'s No. 1 S. C. Bryant, NW¼ Sec. 369, Blk. 1-T, T.&N.O. Sur. R.U.R.

## E. C. TEXAS WILDCATS

**Anderson County**

A. Baggett's No. 1 J. R. Gillispie, J. R. Ferguson Sur., 2½ mi. NE of Frankston. S.D. 4,350 ft.

R. H. Williamson No. 1 O. G. Rogers, Wm. Greenwood Sur., 6 mi. SW of Elkhart. S.D. 4,450 ft.

**Angelina County**

Ginter Bros. No. 7 Copes Hrs., J. Morin Sur., 3 mi. E of Dibol. S.D. 800 ft.

K. L. McHenry's No. 2 Russell est., A. Flores Sur., 4 mi. N Lufkin. Prep. rng. csg. topped sd. 1,002 ft. 2 B.O. and 4 B.W. in 5 min.; pmp. 16 B.O. and 34 B.W.P.D.

**Falls County**

R. D. Salisbury No. 1 W. M. Shankle, J. A. Manchaca Sur., 1½ mi. NE Chilton. S.D. 1,274 ft.

**Fannin County**

H. W. English's No. 1 T. W. Ayers, J. D. Seales Sur. S.D. 687 ft.

C. Newburn's No. 1 A. G. Allen, M. Caldwell Sur., 7 mi. NE of Banham. Drk.

**Grayson County**

Ross & Marshall's No. 2 E. Christman, M. Ahult Sur., 5 mi. NW of Denison. S.D. 852 ft.; S.S.O. 842-43 ft.

Rutledge Oil Co.'s No. 1 Williams, S. Nix Sur., 2 mi. NE of Van Alystine. Drlg. 4,469 ft.

**Hill County**

Carter-Bowland's No. 1 J. J. Atchison estate, E. Carrol Sur., 5 mi. W of Hillsboro. S.D. 85 ft.

**Houston County**

J. C. Cook and Shell Oil Co.'s No. 1 B. T. Masters, Levina Carpenter Sur., ½ mi. NW of Grapeland pool; 10,000-ft. test. C.O. 6,060 ft.; flwg. 1 B.O. and considerable gas.

J. C. Wynne et al's (Shell Oil Co., Inc.) No. 1 G. E. Dorsey, M. Sallas Sur., 2¼ mi. S of Percilla; E 102 ac. of tr.; 10,000-ft. test. Prep. rn. csg. 6,768 ft.

**Hunt County**

K. E. Jennings' No. 1 V. T. Banks, J. W. Haynes Sur., 5 mi. NE of Greenville; reinstated to test sec. at 2,114 ft.; P.B. 2,114 ft.; swbd. dry; S.D.

Westmount Oil Co.'s No. 1 Clark, W. H. Williams Sur., 1 mi. NW of Celeste. Drlg. 2,750 ft.

**Leon County**

Lone Star Gasoline Co.'s No. 2 A. Jones, J. M. H. Jones Sur., Buffalo gas area. Drlg. 500 ft.

**Limestone County**

M. Samuel's No. 1 C. Barrow, W. G. McKinsey Sur., 4 mi. NW of Thornton. P.B. to test.

**Navarro County**

J. H. Burke's No. 1 fee, Edmonson Sur., 1 mi. N of Powell. Drlg. 1,055 ft.

C. F. Carter's No. 1 Allen Eden, M. Shire Sur., 2 mi. NE of Angus. S.D. 1,200 ft.

**Rusk County**

Marietta Corp.'s No. 1 E. B. Alford, Thos. Howeth Sur., 1 mi. S of Pinehill. R.U.

A. O. Whittington's No. 1 Kangerga Bros., Ign. Castro Sur., 9½ mi. N and slightly E of Pirtle. Bldg. drk.

**Red River County**

Dave Flesch's No. 1 Bailey, J. Robbins Sur., 1 mi. W of Bagwell. S.D. 3,415 ft.

### GULF PORT SHIPMENTS

(In barrels)

| Coastwise | Crude | | Refined products | |
|---|---|---|---|---|
| Port districts— | July | August | July | August |
| Beaumont-Port Arthur | 6,884,483 | 6,027,374 | 8,495,650 | 8,476,580 |
| Houston-Texas City | 3,861,763 | 2,263,078 | 7,412,236 | 6,288,207 |
| Corpus Christi-Harbor Island | 3,320,801 | 3,160,267 | ..... | ..... |
| Rio Grande Valley | ..... | ..... | 144,200 | ..... |
| Mississippi River | 789,357 | 990,951 | 1,221,399 | 393,407 |
| Total coastwise | 14,816,404 | 12,441,670 | 17,273,985 | 15,158,194 |
| **Exports** | | | | |
| Beaumont-Port Arthur | 1,208,873 | 2,165,312 | 1,685,053 | 2,112,257 |
| Houston-Texas City | 2,389,629 | 521,057 | 2,418,119 | 553,157 |
| Corpus Christi-Harbor Island | 1,282,690 | 1,140,690 | ..... | 581,766 |
| Rio Grande Valley | ..... | ..... | 173,965 | ..... |
| Mississippi River | 623,168 | 168,264 | 315,795 | 267,013 |
| Total export | 5,504,360 | 3,995,323 | 4,592,932 | 3,514,193 |
| Total coastwise | 14,816,404 | 12,441,670 | 17,273,985 | 15,158,194 |
| Total shipments | 20,320,764 | 16,436,993 | 21,866,917 | 18,672,387 |

**Kansas-Oklahoma Pet. Corp. No. 1 R. H. Ringwald, A. Moore Sur., 3 mi. W of Manchester. S.D. 1,000 ft.**

**Smith County**

**Shell Oil Co., Inc.'s No. 1 H. Campbell, P. Lively Sur., 1½ mi. N of Chapel; 9,500-ft. test. Drlg. 3,585 ft.**

**Trinity County**

**Gossage et al's No. 1 First Natl. Bnk., B. F. Wright Sur., S of Trinity. R.U. and S.D.**

## NORTH TEXAS WILDCATS

**Archer County**

**L. T. Burns' No. 1 J. Penartz, Sec. 19, Clark & Plumb Sur., Blk. 4. Drk.**
**L. B. Burns' No. 1 H. Wilmut, Lot 13, G.N. Smith Sur., Abst. 393 (4,400-ft. semiwildcat). 6⅝-in. 4,384 ft.; W.O.C.**
**W. B. Hamilton's No. 5 C. E. Graham, J. D. Young Sur. A-1249. 6⅝-in. 5,205 ft.; W.O. spdr.**
**Waldo E. Stephens et al's No. 1 Hattie B. Adae, SE part of Blk. 7, Palo Pinto Co. Sch. Lds., 3 mi. SE of Griffin pool. Set 10-in. 100 ft.; drlg. 3,500 ft.**

**Clay County**

**L. T. Burns No. 1 J. T. Pickett, W. W Yearly A-745. 6⅝-in. 4,430 ft.; O.S. 4-430-44 ft.; P.B. 4,380 ft.; drld. out to 4,450 ft.; S.D.O.**
**Continental Oil Co. et al's No. 1 O. O. Ross, W. Walker Sur. A-703. Set 158 ft. 10-in.; drlg. 4,750 ft.**
**Frabor-Hodges and Sinclair Prairie Oil Co.'s No. 1 Scaling, G. P. Meade Sur., Abst. 928. Drlg. 1,800 ft.**

**Cooke County**

**Heydrick et al's No. 1 W. Franklin, A. Rodiquez Sur. A-851. Loc.**

**Cottle County**

**J. E. Burns et al No. 1 J. E. Moss, Sec. 5, Blk. L, A. Forsythe Sur. Jnkd. 225 ft.; skd. 20 ft. S; drlg. 1,820 ft.**

**Hardeman County**

**Carter & Taylor's No. 1 Norton, NW cor. 91-ac. tr. in Blk. 3, Robt. Young Sur., 16 mi. N of Quanah. S.D. 256 ft.**

**Jack County**

**Harper Pet. Corp. No. 2 S. V. Vanhooser, Abst. 1926, J. W. Morrow Sur. T.D. 2,030 ft.; S.D.O.**
**Pitzer & West's No. 1 Sloan, Sec. 2786, T.E.&L. Sur. Drlg. 2,604 ft.**

**Montague County**

**W. H. Gant and Continental's No. 1 J. L. Brown, Sec. 58, E.T.R.R. Sur. Drlg. 6,190 ft.**

**Wichita County**

**Grisso Roy. Co.'s No. 1 Barwise est., T. E.&L. Sur., Sec. 838. Drlg. 790 ft.**

**Wilbarger County**

**Rogers & Cavin No. 1 A. P. Morris, Sec 3, Blk. 14, SW of Harrold. S.D. 2,373 ft.; wtr.**

**Wise County**

**W. F. Holifield et al's No. 1 J. Redell, Rebecca Coleman Sur., Abst. 155, 2 mi. E of Bridgeport. Moved off spdr.**
**C. A. Johnston and others' No. 1 J. C. Vance, Sec. 37, T.&P. Sur. S.D. 1,313 ft.**
**H. M. Muse No. 1 F. F. Kaker, Blk. 16. Matagorda Co. Sch. Ld. Pits.**

**Young County**

**Burns Oil Co. (Floyd Scott) No. 1 W. J. Rhoades, SW B. F. Kutch Sur. Abst. 1,333. Drlg. 260 ft.**
**H. W. Dyer's No. 1 M. G. Cheney, M. L. Terry Sur., Abst. 1261. Loc.**
**A. T. Strong et al's No. 1 E. C. Stovall, Sec. 2946, T.E.&L. Sur. (4.800-ft. test). Drlg. 670 ft.**
**Taubert & McKee Drlg. Co.'s No. 1 Shanafelt, P. Pointevent Sur., Abst. 1309. 6⅝-in. 4,012 ft.; treating 2,000 gal. acd. 4,437-4,500 ft.; fsg. tbg.**

## EAST TEXAS

***(Border Counties)***

**Marion County—Other**

**R. W. Cosby's No. 1 Decker, 150 ft. cor. 33-ac. tr. Set 10-in. csg. 100 ft.; S.D. 250 ft.**
**M. D. Fitzwater No. 1 Mrs. Mary Duncan, Jesse Fitzgerald Sur. T.D. 2,558 ft.; swbd. and bailed dry; tstg.**
J. D. Reynolds' No. 5 Terry est., W. Coore Sur. T.D. 2,359 ft.; W.O.S.R.
J. D. Reynoid's No. 3-B Terry est., 660 ft. EL, 2,250 ft. SL, W. Coore Sur. T.D. 2,025 ft.; S.D.
Sutton et al's No. 1 W. Taylor, 450 ft. EL, midway N and SL, B.B.B.&C.R.R. A-54 Sur. Set 6-in. csg. 2,289 ft.; T.D. 2,313 ft.; pulled inr.; swbd. dry; S.D.

**Marion County—Rodessa**

Gulf Oil Corp.'s No. 3 Ray, 514 ft. NL, 641 ft. EL, 65-ac. tr., J. Hanks Sur. Set 5½-in. csg. 5,973 ft.; T.D. 6,017 ft. W.O.C.
C. H. Lyons' No. 1 Jackson, 473 ft. NL, 460 ft. WL, 20-ac. tr., J. Hanks Sur. Set 5½-in. csg. 6,057 ft.; T.D. 6,087 ft.; W.O.C.
Shell Oil Co., Inc.'s No. 3 Whelan, 330 ft. S and W line tr., T. Gillespie Sur. Rng. 5½-in. csg.; T.D. 5,996 ft.

**Shelby County**

W. H. Neel et al's No. 1 J. W. Hanson, C 64-ac. tr., A. Sanford Sur. M.I.M.

## WEST CENTRAL TEXAS DISTRICT

**Brown County**

A. D. Bruce's No. 1 L. S. Mauldin, SW¼ Sec. 15, H.T.&B. Sur., Abst. 464. S.D. O. 1,691 ft.
Kynaston & Cullison's No. 1 L. A. Hill SW¼ Sec. 35, H.T.&B. Sur. S.D. 1,000 ft.
C. C. Lockwood's No. 1 T. B. Landreth, SE cor. of Subdivision 2, J. Dickinson Sur. 10. S.D.O. 923 ft.; S.S.O. 922-23 ft.
Plains Prod. Co.'s No. 1 Hill, SE cor. W 123 ac. of M. Mudgett Sur. 63. S.D.O. 1,120 ft.
Wilson Oil Co., Inc., No. 1 M. Bowden, Sec. 138, W. E. Gilliland Sur. S.D.O. 2,100 ft.

**Callahan County**

S. B. Roberts' No. 1 Mitchell, SW NE Sec. 28, B.A.L. Sur., outpost to Bowles pool. Prep. comp.

**Coleman County**

B. Banner's No. 1 R. R. Powell, NW part of Moses Little Sur. 40. S.D.O. 1,350 ft.
Kynaston-Culberson-Culberson & Bozeman No. 1 J. P. McCord, Sec. 159. J. W. Meeks Sur. S.D.O. 2,300 ft.
States Oil Corp.'s No. 1 J. P. Morris, SE part of J. P. Stone Sur. 6. Loc.

**Concho County**

Natural Resources Corp. No. 1 Armor, Sec. 105, Blk. 72, T.&N.O. Sur. S.D.O. 1,216 ft.

**Coryell County**

W. E. Crews' No. 1 S. C. Blanchard, W part of Wm. H. King Sur., 2 mi. SW of Mound, 5,000-ft. test. Loc.

**Eastland County**

Dobbs Oil Corp.'s No. 1 Pierce, 330 ft. SL and 330 ft. EL of 214-ac. tract in Sec. 35, Blk. 2, H.&T.C. Sur. Drlg. 1,235 ft.
R. R. Groce's No. 1 J. M. Rush, Sec. 130, Blk. 3, H.&T.C. Sur. S.D.O. 1,728 ft.
F. S. Holden's No. 1 J. F. Nichols, L. A. McDonals Sur., Abst. 829. Drlg. 1,115 ft.
Lone Star Gas Co.'s No. 1 F. J. Kimmel Sec. 87, Blk. 4, H.&T.C.R.R. Sur. Drlg. 2,344 ft.
J. L. Reeves No. 1 J. V. Parker, NW part of Wm. Van Norman Sur. Fsg. 3,077 ft.; S.S.O. 3,019-41 ft.; S.D.O. 3,077 ft.
W. A. Stiles et al's No. 1 H. F. Duncan, Sec. 10, Blk. 2, H.&T.C.R.R. Sur Pits.

**Erath County**

Wayne Chandler's No. 1 Chandler, J. W Moore Sur., Abst. 571. Drlg. 5,052 ft.
T. Gray's No. 1 C. Young Hrs., NW cor of Stephen Smith Sur., Abst. 682 S.D.O. 89 ft.
T. G. Jackson No. 1 J. W. Taylor, Prater Sur., Abst. 1029, 4 mi. NE of Desdemona. S.D. csg. 2,400 ft.
J. F. Monissey et al's No. 1 R. J. Sikes, J. Hargrave Sur., 6 mi. N of Stephenville; 5,000-ft. test. S.D.O. 330 ft.

**Fisher County**

S. and D. Daube's No. 2 Bennett, NE¼ Sec. 51, Blk. 2, H.&T.C. Sur. Drlg. 3,509 ft.

**Hamilton County**

Wallace & Vickers' No. 1 C. C. Lund, J P. Bailey Sur. 51. S.D.O. 3,453 ft.

**Haskell County**

K. N. Nowels' No. 1 M. S. Pardue, SW cor. Sec. 1, S.F.I.W. Sur., 4½ mi. east Stamford. Loc.

**Jones County**

Butler & Horne's No. 1 J. C. Thompson, Sec. 48, Blk. 18, T.&P. Sur. Fsg. 100 ft.
Danciger O. & R. Co.'s No. 1 B. P. Davenport, NE¼ Sec. 23, D.D.&A. Sur. Loc.
Fain-McGaha Oil Corp.'s No. 1 L. T. Burns, S½ SE¼ Sec. 38, Blk. 15, T.&P. Sur. Drlg. 1,400 ft.
Healey & Walters' No. 1 Warren, D. P. Rowland Sur. Drlg. 2,604 ft.
Keeler's No. 1 Radford, SE¼ Sec. 20, Blk. 4, H.&T.C.R.R. Sur. S.D.O. 1,800 ft.
Palo Pinto O. & G. Co.'s No. 1 F. A. Johnson, Sec. 61, Burleson C.S.L. Sur. Loc.
L. H. Pearson's No. 1 P. V. Nelson, SE¼ Sec. 186, B.B.B.&C. Sur. Loc.
Ungren & Frazier and Hedrick Oil Co.'s No. 1 H. F. Lewis, NW cor. Sec. 6, Subd. 7, W. C. Walker Sur. Loc.

**Johnson County**

Geo. C. Foster's No. 1 Pennington, C W 40 ac. of J. E. Pennington 247-ac. tr., ½ mi. SW of Cleburne; contract depth 3,500 ft. Loc.

**Mills County**

A. W. Tanner's No. 1 M. J. Ivy, M. Rhyne Sur., 2 mi. SW of Ebony; contract depth 1,450 ft. Loc.

**Nolan County**

Green & Owens' No. 1 Tipton, Sec. 43 Blk. 19, T.&P. Sur. Sat. from 5,135-38 ft.; 116 B.O. in 2 hrs.; est. 450 B.O P.D.; swbg. and C.O. 5,140 ft.
Plymouth Oil Co. No. 1 F. M. McClure Sec. 49, Blk. 23, T.&P. Sur., 8,000-ft test. Drlg. 4,780 ft.; with rotary.

**Palo Pinto County**

J. Jones' No. 1 R. H. Gauldin, NW cor Sec. 1743, T.E.&L. Sur. S.D.O. 207 ft.

**Parker County**

Brown & Gardner Bros. No. 1 Gilbert T.&P. Sur., Abst. 1958. Drlg. 3,230 ft.

**Shackelford County**

Georgian Oil Corp.'s No. 1 Blach ranch, C NE¼ of T.E.&L. Sur. No. 390, 10 miles NE of Albany, Ordovician test Loc.

**Stephens County**

Geo. E. Fagg No. 1 Richardson, Sec. 6 Blk. 31, S.P.R.R. Sur.; 4,000-ft. test S.O. 3,430-45 ft.; drlg. 3,450 ft.
T. G. Shaw, Tr.'s No. 1 S. P. Stroud NW¼ of G. Newton Sur., Abst. 125 Sd. 2,597-2,600 ft.; tstg. 68 bbl. oil in 11 hrs.
Wittmer O. & G. Co.'s No. 2 B. D. Loving, NE¼ Sec. 11, O.A.L. Sur. Spdg.

**Stonewall County**

Shell Oil Co., Inc., No. 1 A. E. Smith Sec. 143, Blk. 1, H.&T.C. Sur.; 6,000 ft. test. U.R. 3,128 ft.; T.D. 3,240 ft.

## Rocky Mountain Runs

Production estimates for week ended November 11:

| | Bbl. |
|---|---|
| **WYOMING** | |
| Salt Creek | 15,140 |
| Big Muddy | 1,190 |
| Badger basin | 140 |
| Byron | 60 |
| Cole Creek | 140 |
| Dallas Derby | 570 |
| Dewey dome | 10 |
| Dutton Creek | 40 |
| Elk basin | 620 |
| Frannie | 990 |
| Garland | 2,540 |
| Grass Creek | 1,830 |
| Hidden dome | 80 |
| Hudson | 240 |
| LaBarge | 730 |
| Lance Creek | 19,560 |
| Lost Soldier | 1,740 |
| Mahoney | 270 |
| Medicine Bow | 1,550 |
| Mule Creek | 200 |
| Midway | 30 |
| Oregon basin | 2,830 |
| Osage | 800 |
| Quealy dome | 530 |
| Rock River | 3,110 |
| Teapot | 20 |
| Warm Springs | 140 |
| Wertz | 3,780 |
| Total Wyoming | 58,880 |
| **MONTANA** | |
| Border | 210 |
| Cat Creek | 530 |
| Cut Bank | 9,790 |
| Dry Creek | 1,060 |
| Kevin-Sunburst | 4,550 |
| Pondera | 970 |
| Total Montana | 17,110 |
| **COLORADO** | |
| Florence | 120 |
| Fort Collins and Wellington | 440 |
| Wilson Creek | 390 |
| Iles dome | 1,900 |
| Moffat | 320 |
| Rangely | 100 |
| Tow Creek | 130 |
| Price | 570 |
| Total Colorado | 3,970 |
| **NEW MEXICO** | |
| Cooper | 3,910 |
| Eaves | 830 |
| West Eunice | 140 |
| Eunice | 21,090 |
| Hardy | 3,660 |
| Hobbs | 10,540 |
| Jal | 560 |
| Langlie | 5,140 |
| Lynch | 470 |
| Lynn | 920 |
| Mattix | 5,260 |
| Monument | 22,100 |
| North Lynch | 30 |
| Penrose | 5,150 |
| Rhoades | 110 |
| Skaggs | 90 |
| Skelly | 1,800 |
| South Eunice | 4,030 |
| South Livingston | 1,100 |
| Vacuum | 11,190 |
| Artesia-Maljamar | 11,700 |
| Getty | 100 |
| Hogback | 200 |
| Rattlesnake | 680 |
| Table Mesa | 90 |
| Halfway | 50 |
| Total New Mexico | 110,940 |

## CRUDE-OIL PRICES IN REPRESENTATIVE FIELDS

Complete crude-price schedules are now being published in the first issue of each month. The last complete schedule was published in the November 2 issue. All changes in crude-oil-price schedules will be published completely in the first issues following the announcement of the changes. Following are representative crude-price schedules in barrels (42 gal.):

| | |
|---|---|
| East Texas | $1.10 |
| Conroe | 1.27 |
| Tepetate, Louisiana | 1.03 |
| Smackover, Arkansas, heavy | .73 |
| Illinois basin | 1.05 |
| Pecos County, Texas | .78 |
| Lance Creek, Wyoming | .77 |
| Bradford, Pennsylvania | 2.40 |

### Gravity Schedule

Top prices include all gravities above grades designated, and low prices include all gravities below grades designated:

| | Signal Hill, California | Oklahoma, Kansas | Gulf Coast Texas |
|---|---|---|---|
| 14-14.9 | $0.80 | .... | .... |
| 15-15.9 | .80 | .... | .... |
| 16-16.9 | .80 | .... | .... |
| 17-17.9 | .80 | .... | .... |
| 18-18.9 | .80 | .... | .... |
| 19-19.9 | .82 | .... | $0.86 |
| 20-20.9 | .85 | $0.70 | .88 |
| 21-21.9 | .88 | .72 | .90 |
| 22-22.9 | .92 | .74 | .92 |
| 23-23.9 | .95 | .76 | .94 |
| 24-24.9 | .99 | .78 | .96 |
| 25-25.9 | 1.03 | .80 | .98 |
| 26-26.9 | 1.06 | .82 | 1.00 |
| 27-27.9 | 1.10 | .84 | 1.02 |
| 28-28.9 | 1.14 | .86 | 1.04 |
| 28-28.9 | 1.17 | .88 | 1.06 |
| 30-30.9 | 1.21 | .90 | 1.08 |
| 31-31.9 | .... | .92 | 1.10 |
| 32-32.9 | .... | .94 | 1.12 |
| 33-33.9 | .... | .96 | 1.14 |
| 34-34.9 | .... | .98 | 1.16 |
| 35-35.9 | .... | 1.00 | 1.18 |
| 36-36.9 | .... | 1.02 | 1.20 |
| 37-37.9 | .... | 1.04 | 1.22 |
| 38-38.9 | .... | 1.06 | 1.24 |
| 39-39.9 | .... | 1.08 | 1.26 |
| 40-40.9 | .... | 1.10 | 1.28 |

## Crude-Oil Price Changes

Simrall Corp. advanced the price of West Branch, Michigan, crude to 85 cents per barrel, a 3-cent advance, effective November 1.

Sohio Corp. posted Bloomingdale and Columbia crudes, in Van Buren County, Michigan, at $1.03, a 5-cent increase, effective November 9.

Effective October 1, but not announced until November 13, Standard Oil Co. of California started posting prices in the Cole's Levee and Richfield Western fields in Kern County, California, ranging from $1 for 27 gravity to $1.61 for 46 gravity and over.

**STOCKS HELD IN PACIFIC COAST TERRITORY BY CALIFORNIA OIL COMPANIES**

| | Sept. 30, 1939 | Aug. 31, 1939 | Sept. changes | Dec. 31, 1938 (reclass'd.) |
|---|---|---|---|---|
| 1 Gasoline-bearing crude | 37,115,203 | 37,876,094 | —760,891 | 36,225,312 |
| 2 Non-gasoline-blending crude | 14,074,602 | 14,266,375 | —191,773 | 16,282,177 |
| 3 Unblended natural gasoline | 2,049,211 | 2,246,222 | —197,011 | 2,699,455 |
| 4 Gasoline (not including distributing and service stations | 13,454,290 | 13,331,736 | +122,554 | 13,259,369 |
| 5 Naphtha distillates | *1,487,704 | *1,450,221 | +37,483 | *1,566,349 |
| 6 Gas oil and diesel oil | 9,979,845 | 10,116,384 | —136,539 | 10,539,937 |
| 7 Fuel oil residum | 68,850,703 | 69,779,076 | —928,373 | 70,957,881 |
| 8 All other stocks | †7,647,251 | †7,517,674 | +129,577 | †6,153,809 |
| Total | 154,658,809 | 156,583,782 | —1,924,973 | 157,684,289 |
| *Estimated amount of unfinished gasoline contained in Item 5 | 1,176,350 | 1,172,235 | ..... | 1,350,379 |
| †Coke included in Item 8 | 597,023 | 478,374 | ..... | 92,066 |

# QUESTIONS ON TECHNOLOGY

*By Charles K. Francis, Ph. D., Technical Editor*

## Grades of Fuel Oil For Varied Oil Burning Equipment

**It is not clear what differences exist in the quality of the several grades of fuel oil, Nos. 1-6. Your explanation will be valued.—T. P. E.**

The Division of Trade Standards, national Bureau of Standards, has recently recommended a revision of the detailed requirements for fuel oils. These are summarized in the table.

REQUIREMENTS FOR FUEL OILS

| Grade— | 1 | 2 | 3 | 5 | 6 |
|---|---|---|---|---|---|
| Flash: | | | | | |
| Minimum | 100 | 110 | 110 | 130 | 150 |
| Maximum | 165 | 190 | 230 | ... | ... |
| Pour | 0 | 10 | 20 | ... | ... |
| Water and sediment | Trace | .05 | .10 | 1.00 | 2.00 |
| Carbon residue | .05 on 10% residue | .25 on 10% residue | .15 straight | ... | ... |
| Distillation temp.: | | | | | |
| 10 per cent | 410 | 440 | ... | ... | ... |
| 90 per cent | ... | 600 | 600-675 | ... | ... |
| End point | 560 | ... | ... | ... | ... |
| Say. Visc. at 100: | | | | | |
| Minimum | ... | ... | ... | 50 | ... |
| Maximum | ... | ... | 45 | ... | ... |
| Say. Fural at 122: | | | | | |
| Minimum | ... | ... | ... | ... | 45 |
| Maximum | ... | ... | ... | 40 | 300 |

Note: Temperatures are °F. All maximum unless otherwise shown. Sulfur limits are 0.5 per cent for Nos. 1 and 2, 0.75 for No. 3 and no limit for Nos. 5 and 6. The ash is maximum 0.10 per cent for No. 5.

Description of grades: No. 1 is distillate oil for use in burners requiring a volatile fuel; No. 2 is distillate oil for use in burners requiring a moderately volatile fuel; No. 3 is distillate oil for use in burners requiring a low-viscosity fuel; No. 5 is oil for use in burners requiring a medium-viscosity fuel; No. 6 is oil for use in burners equipped with preheaters permitting a high-viscosity fuel.

Reference: Fuel Oils, Commercial Standard CS12-38, Sept. 30, 1939, TS-2741, Division of Trade Standards, national Bureau of Standards, Washington, D. C.

## Calculating Vapor Pressures From Molecular Weights

**Will you favor me with the rule for calculating vapor pressures from molecular weights of substances? — E. F. A.**

According to the Phase Rule and Raoult's law (see this page July 20, 1939) the addition of another substance to a pure liquid must change the composition and therefore the vapor pressure. This may be explained from the calculation of the vapor pressure of a water solution containing 10 per cent cane sugar ($C_{12}H_{22}O_{11}$).

Water = 18 mol wt.
Sugar = 342

$$\frac{0.10}{342} = 0.000292$$

$$\frac{0.99}{18} = 0.055$$

Total 0.055292

Then the mol fraction of the sugar is $\frac{0.000292}{0.055292}$ or 0.00528, and the mol fraction of water in the solution is 1 — 0.00528 or 0.99472. The standard-normal vapor pressure of water at 100° C. is 760 mm., consequently the vapor pressure of the 10 per cent sugar solution is 0.99472 × 760 or 756 mm.

The mixture of a heavy oil and light oil may be compared to the condition where a non-volatile substance is dissolved in a volatile liquid with the exception that the partial pressure of the light oil and not the total vapor pressure must be used. Example, What is the partial pressure of benzene ($C_6H_6$), in a mixture containing 20 per cent toluene ($C_6H_5CH_3$) at 80° C.?

Benzene = 78.05 mol wt.
Toluene = 92.06 mol wt.

Therefore the 100 per cent relation is

$$\frac{80}{78.05} = 1.025 \text{ mols benzene}$$

$$\frac{20}{92.06} = 0.217 \text{ mols toluene}$$

Total 1.242 mols present.

Then the mol fraction of toluene is $\frac{0.217}{1.242}$ or 0.1747 and benzene is 1.0 — 0.1747 = 0.8253. Pure benzene has a vapor pressure of 753.6 mm. at 80° C. Hence, the partial pressure of benzene here is 753.6 × 0.8253 = 622 mm.

Reference: Robinson, Fractional Distillation, p. 32.

Questions on Petroleum Technology may be sent to Dr. Charles K. Francis, The Oil and Gas Journal, Tulsa, Okla. When a copy of the answer is desired, postage should be included.

## Physical and Chemical Laws and Principles Used in the Petroleum Industry

### THEORY OF ELECTROLYTIC DISSOCIATION

**(Ionization Theory)**

It is supposed that when such substances as acids, alkalis and salts, dissolve in water, or other dissociating solvents, the molecule separates into two parts, one being charged with positive electricity, designated cations, and the other negatively charged, termed anions. These parts are known as ions.

Related to the subject is the electron theory, which explains that the atom consists of a positively charged nucleus, changing in character with each kind of atom, the nucleus being surrounded by negatively charged electrons. The nucleus consists of protons and the revolving electrons are satellites.

Solutions always contain a balance in the number of positive (+) and negative (−) ions. The pH value of a solution, or, hydrogen ion concentration, is the logarithm of the reciprocal gram hydrogen equivalent per liter, or pH = $\log \frac{1}{H^+}$ per liter. Water has a concentration of $H^+$ of $10^{-7}$ and $OH^-$ of $10^{-7}$ mols per liter, designated 7 pH value.

## Formula for Indicating Removal of Impurities for Color Reduction

**What is the mathematical formula for expressing color reduction in the refining of lubricating oil?—S. E. J.**

In the chapter on "Refining by Adsorption," Kalichevsky and Stagner give a description of the mathematical expression of the general adsorption isotherm of Freundlich, for the removal of undesirable constituents from oils, which is expressed:

$$\frac{x}{m} = KC^n$$

where

$x$ = units of impurities removed
$m$ = quantity of adsorbent used
$C$ = equilibrium concentration of the impurities in the oil
$K$ and $n$ = constants, depending on the nature of the adsorbent, substances adsorbed and the solvent.

This converted to logarithmic form is:

$$\log \frac{x}{m} = \log K + n \log C$$

This equation shows that the plotting of the values of $\log \frac{x}{m}$ against $\log C$ gives a straight line with a slope, $n$ intersecting the $y$ axis at a point $\log K$.

A study of the equation reflects the advantageous influence of fractional addition of adsorbents to the oil, and better utilization of the adsorbent than direct contacting because percolation is equivalent to applying the adsorbent in an infinite number of stages. However, contacting is chosen over percolation for other reasons.

Oils should be treated for color separately, mixing after decolorizing in preference to mix first and then treat.

The practical application of the adsorption equation for testing oils is as follows: An oil is treated with a standard clay and the coefficients $K$ and $n$ are evaluated from the graph. The same coefficients are then determined for a sample of clay of unknown efficiency and the first of the resulting equations:

$$\frac{x}{Mstd} = Kstd\ C^{Nstd}$$

and

$$\frac{x}{Mun} = Kun\ C^{Nun}$$

is divided by the second. The resulting equation:

$$\frac{Mun}{Mstd} = \text{efficiency} = \frac{Kstd}{Kun} C^{(Nstd-Nun)}$$

$$= KC^{(Nstd-Nun)}$$

can be plotted graphically and used for evaluating the adsorbent for the particular oil.

References: Kalichevsky and Stagner, Chemical Refining of Petroleum. H. Freundlich, Kapillarchemie, p. 232. L. L. Davis, The Oil and Gas Journal, Mar. 8, 1928, p. 148.

# Personal Paragraphs

D. D. THOMAS, head of the Thomas Drilling Co., formerly of San Angelo, Tex., has moved his company to Artesia, N. M. Mr. Thomas and his sons compose the company and have gone to Artesia.

SAMUEL MESSER, of Oil City, Pa., vice president and director of James B. Berry Sons' Co., and a director in the Quaker State Oil Refining Co.; C. L. SUHR, of Oil City, chairman of the board of Pennzoil Co., and MERRILL N. DAVIS, of Bradford, executive vice president of Dresser Manufacturing Co., have been appointed members of an advisory council of 50 Pennsylvania industrialists, employers and university heads who will assist the job-mobilization committee.

F. S. SEELY, drilling contractor of Houston, Tex., left last week for an inspection tour through Mississippi.

E. H. MOORE, president of E. H. Moore, Inc., was a recent visitor to the new Tinsley Dome pool of Mississippi.

OTTO KOCH, president of the Kendall Refining Co., Bradford, Pa., and Mrs. Koch are visiting in St. Petersburg, Fla.

J. THOMAS McGLOTHLIN, scout with the Gulf Refining Co., has been transferred from Shreveport, La., to Mississippi.

JAMES GRANT MANLEY, geologist for the Standard Oil Co. of Venezuela, is returning to the United States for a short visit.

J. E. MOOREHEAD, executive secretary of the Pennsylvania Grade Crude Oil Association, will direct the Christmas seal campaign of the Venango County Tuberculosis Society again this year.

J. M. CLAYTON, geologist for the Seaboard Oil Co. at Dallas, Tex., addressed the Houston Geological Society last week. He discussed "Producing Formations Above the Jackson in Southwest Texas."

GEN. A. D. McRAE, W. P. CASHMAN and REDMOND CODE, officials of the Texas Canadian Oil Co., are making a tour of the company's oil properties, visiting North Louisiana, East Texas and South Arkansas before returning to Toronto, Canada.

GEORGE T. PEW, son of J. Howard Pew, president of Sun Oil Co., has become engaged to marry MISS CONSTANCE DELL CLARKE.

H. C. CREATH, of Colombian Petroleum Co., Barco, Colombia; M. P. McGUIRE, of Kern Trinidad Oilfields, Trinidad; GEORGE FIRESTONE, of Attock Oil Co., India; ROBEY DEAN, of B. O. C., Venezuela; L. M. STANFIELD, of Standard Oil of Venezuela, Maracaibo; W. T. LEITZ and W. STARRENBURG, of the B.P.M., The Hague, Netherlands; A. N. McKENZIE, formerly with Sinclair Oil Co. in Venezuela; A. F. DRISCOLL, of B.O.D.C., Iraq; and ARCHIE BROWN, of Caribbean Petroleum Co., Maracaibo, Venezuela, who have been visiting in this country, were recently guests of the California Nomads at a dinner.

J. S. BRIDWELL, president of Bridwell Oil Co., Wichita Falls, Tex., recently gave 400 acres of proven oil land in Webb County, South Texas, to 89 of his employes who have organized the Bridwell Employes Oil Co. with R. A. BIRK, geologist; A. L. HECK, office manager, and A. T. JUNK, superintendent. "I've been intending to show my appreciation for the services of my employes for some time," Mr. Bridwell said. "I decided this was a good way to do it."

E. W. MARLAND, president of the Marland Oil Co. of Oklahoma, and former governor of the state, has offered his mansion at Ponca City, Okla., as a home for aged oil operators and workers. The idea is to surround the mansion with a colony for retired oil men. In announcing his plans Mr. Marland said: "Oil men helped me to attain prominence and success in Pennsylvania and in Oklahoma. Now I can help to make the last days of many of them comfortable."

JOSE OVIDIO MARTINEZ, of Yacimientos Petroliferos Fiscales (the Argentine Government oil company), who has been studying petroleum engineering in California for 3 months, was in Tulsa last week and will attend the annual meeting of the American Petroleum Institute in Chicago. While in Tulsa he visited TOMAS SUERO, also of Argentina, who, after a course in geology at the Argentine University, is now in Oklahoma completing his studies.

## Do You Remember?

From The Oil and Gas Journal Files

### 25 YEARS AGO

All grades of Oklahoma and Kansas crude excepting Healdton sell for 55 cents per barrel. Healdton crude commands 50 cents.

McMan Oil Co. and Cimarron Valley Oil & Gas Co. are having a line fight in the north extension of the Cushing field with wells drilling 60 ft. apart.

W. S. Farish, a well-known Gulf Coast operator, is looking over the Oklahoma oil fields.

Refinery prices in the Mid-Continent are 38-40 distillate oil, 2⅛ cents; 42-43 water white, 2½ cents; 44-45 water white, 2¾ cents; 46-47 water white, 3 cents; 52-53 naphtha, 5½ cents; 54-56 naphtha, 6 cents; 58-59 naphtha, 6½ cents; 60-62 gasoline, 7 cents; 63-64 gasoline, 8 cents; 66-67 gasoline, 9 cents; 68-70 gasoline, 10 cents.

### 20 YEARS AGO

Mid-Continent crude advances to $2.50 per barrel.

The White Oil Corp., capital $30,000,000, is organized by Patrick J. White and others. Mr. White was senior member of the firm of White & Sinclair in the Cushing boom days.

### 10 YEARS AGO

Heads of land and leasing departments of Kansas and Oklahoma oil companies approve unit operation of oil properties.

California producers have voluntarily reduced their daily crude output 200,000 bbl. per day since November 1. Production has fallen to 665,000 bbl. per day in that state.

Conger Reynolds is appointed director of public relations by Standard Oil Co. of Indiana.

Recent slump in the stock market has lowered the average price of 20 representative oil stocks from $60.90 on August 81 to $47.61 on November 15.

BRANTLEY JACKSON, land man with the Magnolia Petroleum Co., has been transferred from Illinois to Mississippi.

ALFRED W. LOTT, formerly in the president's department of Shell Oil Co., Inc., St. Louis, Mo., has taken a position with Pan American Production Co. at Houston, Tex.

JOHN E. EMERSON, of Buffalo, N. Y., has acquired the 2,100-acre J. P. Eaton Corp. property in the Grand Valley district, Warren County, Pa., and has inaugurated a repressuring project.

JOHN V. TERRILL, formerly chief geologist for the Gulf Oil Corp. in the Texas Panhandle district, has resigned his position and will move to Midland, Tex., where he will enter the geological field as a consultant.

JOHN W. SWARD, independent oil operator, formerly of San Angelo, Tex., and for the past 8 months in Oakland, Calif., has returned to San Angelo and established headquarters for his interests in New Mexico.

CLINT W. JOSEY, president, and DON W. JOSEY, treasurer, of Rancho Oil Co., Dallas, Tex., and MONROE H. GOODE, independent operator of that city, returned from a big-game hunt in New Mexico with trophies that included two bears, three antelopes, a badger, and much small game. The animals bagged did not afford an opportunity for the hunters to try their hand as ropers as originally planned.

LU CURRY, scout for Deep Rock Oil Corp., has resigned and is interested in the southeastern developments.

S. F. SHAW is delivering a series of lectures at the A. & M. College of Texas, and will be in Oklahoma City the latter part of November.

C. P. SWEENY, of the Pan American Refining Co., New York, spent several days in Shreveport, La., and the Gulf Coast on a recent business trip.

E. G. McLAUGHLIN, southern Australian divisional superintendent of Shell Oil Co., Inc., passed through California on the way home to his office.

C. SYDNEY FREDERICK of Covington, La., was named secretary to Ernest S. Clements, commissioner of the Louisiana Department of Conservation.

EDGAR DAVIS, of Lethbridge, Alta., is leaving via New York for Ecuador where he will join the engineering staff of the International Petroleum Co.

O. H. CARLISLE, division manager of Gulf Oil Corp., Houston, Texas, has been named chairman of an advisory committee in charge of arrangements for the National Flower and Garden Show at Houston.

BARTLETT W. GILLESPIE, accompanied by his family, arrived for a vacation in California this week from Argentina where he has been employed by the Argentine Government as technical adviser in the opening of new oil fields in various parts of the South American republic.

## Known for Inventions

Various advancements in the field of oil-refining processes and equipment are credited to the research pioneering of Dr. Clive M. Alexander, who has just been elected vice president of Aetna Oil Service, Inc., in charge of refining and transportation. Inventions which have made his name well known include vapor-phase cracking processes. Back in 1916, as an original inventor, he patented pyrolytic polymerization of refinery and natural gases.

*DR. CLIVE M. ALEXANDER*

Dr. Alexander was educated as a chemical engineer, receiving the degree of Ch.E. at the University of Iowa and that of Ph.D. at Columbia University. His career in oil began with his employment as a chemical engineer by Gulf Refining Co. in 1915, and he immediately began thinking out better ways of performing different plant operations. Later he was with Texas Oil Products Co. and Imperial Refineries as general manager. For a number of years he was a consulting engineer in petroleum refining, including association with Pan American Petroleum Corp. and Shell Oil Co., Inc. He worked with Aetna Oil Service as a consultant for several years before joining that organization January 1, 1939, as manager of refining and transportation.

Dr. Alexander, who was born in Leon, Iowa, resides in Louisville, Ky., where Aetna, an integrated company, has a 7,500-bbl. refinery.

FRANK P. COLBY, Tulsa chief title clerk of the Carter Oil Co., has been confined to his home with influenza.

C. L. MORGAN, of the Lion Oil Refining Co., has been transferred to Mississippi to report on activity for his company.

A. M. CROWELL, director of the Arkansas Oil & Gas Commission, is spending several days at his home in Charlotte, N. C., due to illness of his father.

A. F. MICHAELS, chief of advertising department of Standard Oil Co., with offices in San Francisco, spent last week in southern California on company business.

L. P. ST. CLAIR, former president and chairman of the board of Union Oil Co., until his retirement from business recently, has resigned as a member of the board of directors of the company.

H. B. SPENCE, formerly manager of the Colorado City Chamber of Commerce, has been named executive secretary of the recently organized Permian Basin Association, with headquarters at Midland, Texas. J. L. GREENE of Midland is president.

C. O. STARK, vice president; D. C. HEMSELL, superintendent of the land department, and D. E. LOUNSBERRY, geologist, all of Phillips Petroleum Co. at Bartlesville, Okla., made an inspection tour of the Louisiana and Texas Gulf Coast district the past week. They were accompanied by M. H. STEIG, geologist for the Gulf Coast division at Houston, Tex., and J. J. DOYLE, superintendent of the land department in southeastern Louisiana.

JOHN F. BRICKER, for the past 3 years scout for the Humble Oil & Refining Co. at Midland, Tex., will leave soon for Houston where he will assume new duties in the company's land department. His place at Midland will be filled by SOL BRUNNELL who comes from the company's Hobbs, N. M., office.

Shifts: W. K. HALEY, superintendent Barnsdall Oil Co., from Tulsa to Mankins, Tex.; J. B. BURNETT, Vacuum Oil Co. Pty., Ltd., from Coachella, Calif., to Melbourne, Australia; WILLIAM I. CUNNINGHAM, geologist Bishop Oil Co., from Lodi, Calif., to Bakersfield, Calif.; BOB O. BIRD, superintendent Phillips Petroleum Co., production department, from Perry, Okla., to Duncan, Okla.; ROMAN F. BRACKNEY, driller Gulf Oil Corp., from Spencerville, Ohio, to Standard Oil Co. of Venezuela, Caripito, Venezuela, S. A.; WILLIAM R. CAMPBELL, geologist, Tropical Oil Co., from Barranca-Bermeja, Sant., Colombia, S. A., to Berkeley, Calif.; HENRY R. KIMBLE, geologist, Magnolia Petroleum Co., from Dallas, Tex., to Socony-Vacuum Oil Co., Caracas, Venezuela, S. A.; N. E. GRISHAM, Grisham & Grisham, from Tyler, Tex., to Eastland, Tex.; JOHN McFAYDEN, vice president Ohio Oil Co., from Casper, Wyo., to Los Angeles, Calif.; BEN BANNER, Banner Oil & Gas Co., from Oklahoma City, Okla., to Fort Worth, Tex.

RALPH P. BOLTON, general manager of the European production division of Standard Oil Co. of New Jersey, with headquarters in The Hague, was a visitor at the Tulsa offices of Carter Oil Co. this week. He came to the United States for a combined business and vacation trip several weeks ago. He and Mrs. Bolton have been touring the nation.

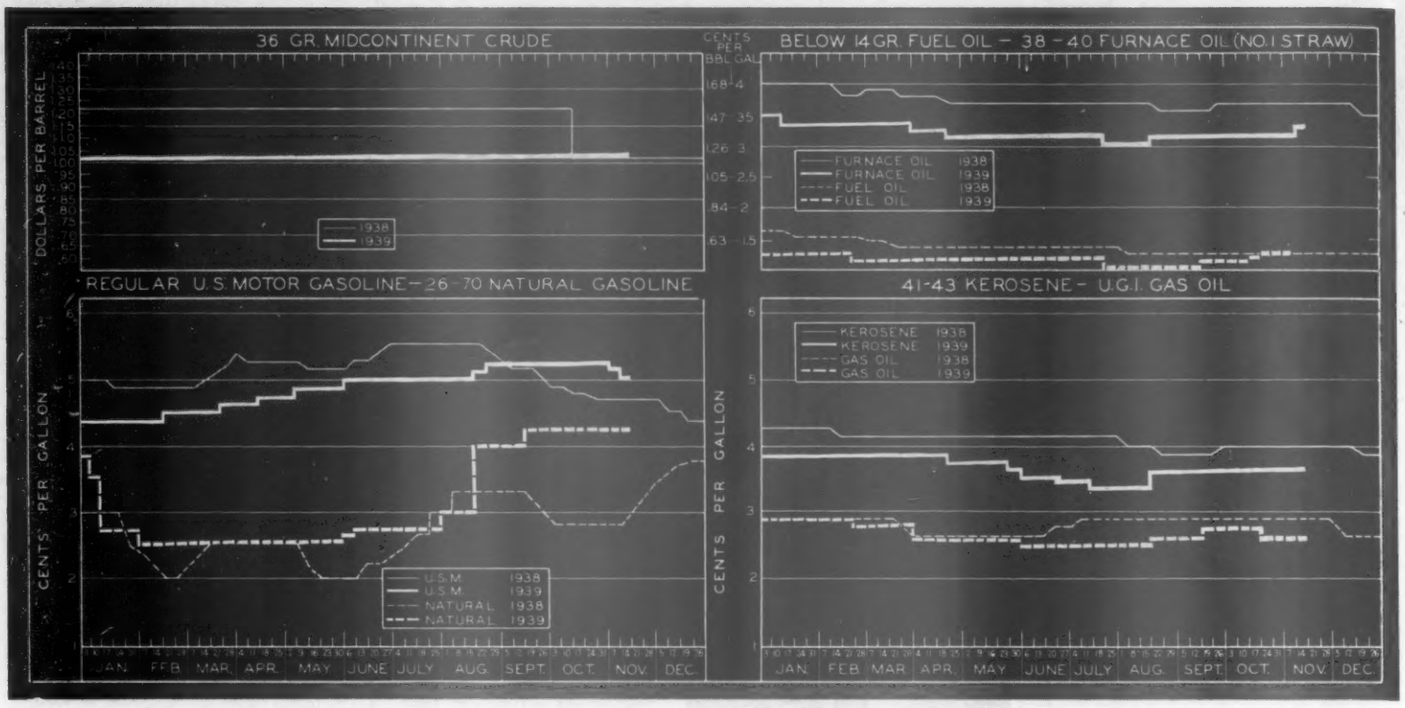
J. C. (JACK) JONES, district foreman of the Humble Pipe Line Co., Pampa, Tex., delivered an address on the relation of pipe lines to business at the meeting of the Panhandle of Texas chapter of the A.P.I. in Pampa, November 14. Other speakers included GEORGE A. LEE, assistant district superintendent of the Humble Pipe Line Co. of West Texas and the Panhandle. He traced the history of pipe lines.

MERRELL R. FENSKE, director of the petroleum refining laboratory of Pennsylvania State College, addressing the Michigan-Life conference on new technologies in transportation, urged consumer education and continued researches in the physics and chemistry of lubrication. Particularly, Mr. Fenske pointed out the need for new information on the oxidation of lubricating oils which, he explained, present the most serious problems in the lubrication of modern internal combustion engines.

BOB FOREE, independent operator of Dallas, Tex., left last week for a 10-day bear hunting excursion into the Mexican mountains some 150 miles southwest of Eagle Pass. Several Texas and Oklahoma oil men make up the party.

W. C. FRITZ, geologist with Skelly Oil Co. at Midland, Tex., will deliver a paper on "North-South Cross-Section of Permian Basin" at the joint meeting of the Panhandle Geological Society and the West Texas Geological Society at Lubbock, Tex., November 24.

DR. ROBERT E. WILSON, president of Pan American Petroleum & Transport Co., New York, received the Chemistry Industry Medal of the Society of Chemical Industry, at a joint meeting of the Society of Chemical Industry and the American Chemical Society on November 10. The medal is awarded annually for valuable application of chemical research to industry and was given to Dr. Wilson in recognition of his research studies on such subjects as flow of fluids, oiliness, corrosion, motor-fuel volatility, clay and glue plasticity, and humidity, and in recognition of his industrial contributions in the use of tetraethyl lead, petroleum hydrocarbon cracking, and adoption of chemical engineering principles by the oil industry.


36 GR. MIDCONTINENT CRUDE
DOLLARS PER BARREL
1938
1939
CENTS PER BBL. GAL.
BELOW 14 GR. FUEL OIL — 38 - 40 FURNACE OIL (NO. 1 STRAW)
FURNACE OIL 1938
FURNACE OIL 1939
FUEL OIL 1938
FUEL OIL 1939
REGULAR U.S. MOTOR GASOLINE — 26 - 70 NATURAL GASOLINE
CENTS PER GALLON
U.S.M. 1938
U.S.M. 1939
NATURAL 1938
NATURAL 1939
41-43 KEROSENE - U.G.I. GAS OIL
KEROSENE 1938
KEROSENE 1939
GAS OIL 1938
GAS OIL 1939
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.

Representative Mid-Continent Quotations on Crude Oil and Refined Products, Basis Oklahoma (Group 3)

# *Heating Oils Move Into Foreground of Market Interest in Group 3 Area*

By T. F. SMILEY

HEATING oils moved into the foreground of Group 3 market interest this week, evincing a greater degree of additional strength than any other refined product, with the possible exception of paraffin wax. Motor fuel was increasingly soft. Natural gasoline acted as though it might throw off its inertia.

Quotations on furnace oils moved up, and refiners were displaying no hurry to sell. A tight market in this division is looked for. Although there has been a marked rise in sales of domestic burners and new installations, stocks of fuel for use in them are substantially lower than they were a year ago. If the approaching winter should bring prolonged cold weather, there will be a definite shortage of light fuels, according to predictions. Widening use of oil for cooking purposes increases the likelihood of scarcity.

### Gasoline Needing Outlets

There was enough gasoline looking for quick outlets to make spot quotations crumble a little along the lower edge, although there was an inclination on the part of most refiners to regard favorable factors as outweighing the unfavorable. Tending to brighten the outlook was the fact that a half-dozen cargo orders for immediate coastwise shipment were received by Gulf Coast refiners in the past week. Lifting of this material has no immediate bearing on market conditions in the Mid-Continent, but it does lessen the danger of advantageous conditions already existing in that region being upset by distress material in other areas looking for a place to go.

One evidence of the healthier gasoline situation prevailing in the Mid-Continent territory in comparison with that found in the country at large is seen in the fact that while the nation's stocks are some 4,000,000 bbl. larger than they were a year ago, Mid-Continent stocks have declined more than 500,000 bbl.

Mid-Continent refiners are sharing fully in the heightened consumption of gasoline, estimated at 7 per cent above that in the corresponding period of 1938. Although recent coastwise shipments of gasoline from the Gulf Coast have helped to relieve a troublesome situation, the failure of expected export business to materialize continues to make heavy accumulations at Gulf ports a threat to Gulf Coast refiners and indirectly to inland refiners farther north.

Among informed market observers some express belief that serious fighting in the European conflict will be the signal for important export shipments of gasoline and other petroleum products. These observers say that oversea buyers had big stocks when the war broke out and that though substantial drafts have been made on them, there is little disposition to do replacement buying until severe and extended warfare seems certain. Foreign buyers are in no hurry to risk their tankers on a peril-infested sea.

### Orders From Gulf Coast

Gulf Coast refiners bought natural gasoline in substantial volume in the past week. Whether the material is wanted for blending with the refinery gasoline previously mentioned as ordered for immediate shipment coastwise is not known by the manufacturers. This business from the Gulf was an encouraging incident in the natural market and, with others, helped to impart life.

Excitement which had marked the lubricating-oil market was cooling somewhat, but manufacturers said this division had lost not a bit of its strength. Many contracts for 1939, made when war seemed far away, stipulated that not more than 20 cents a gallon should be charged for 150-160 D bright stock of zero to 10 pour point, with other grades in proportion. Such refiners now are filling contracts at 4 cents under established spot prices. It is said that no 1940 contracts on this "top" basis will be considered by refiners.

### Refined Oil Market Barometer

Colder weather, though imparting life to the heating oils, is accelerating the decline in gasoline consumption. Rising stocks, along with failure of export demand to make expected inroads on accumulations at Gulf ports, is increasing the softness of gasoline. Lubricating oils and wax are holding their gains. The position of heavy industrial fuels improves steadily.

**MID-CONTINENT.** Furnace oils up. Gasoline soft. Lubricating oils and wax vigorous.

**EAST COAST.** Gasoline unsteady, with lower prices predicted. Heavy industrial fuel strong.

**GULF COAST.** Gasoline softer. Lubricating oils extremely tight. Kerosene easier.

**PENNSYLVANIA.** Gasoline lifeless. Wax goes higher. Lubricants holding. Kerosene stronger.

**CALIFORNIA.** Export gasoline firm; domestic soft, with little moving in spot market.

**CHICAGO.** Heating oils stronger. Gasoline irregular. Heavy fuels holding gains.

# Motor Fuel Sags in East Coast Market; Fuel Oils Gaining

By H. STANLEY NORMAN

NEW YORK, Nov. 14.—The motor-fuel market structure at several points along the North Atlantic seaboard presented an easier appearance last week. Changes in the market were confined to the low-octane grades, but observers expressed fear that the entire structure may be adjusted in the near future. Consumption is holding fairly high for this season of the year, and consequently reaction in the market may be slow. Exporters report no change in that branch of the business and shipments are following routine lines.

The fuel-oil market was firm at unchanged prices. Consumption is nearing midwinter proportions and the market is definitely on the strong side, with advances predicted by many in the near future. Most tank-car sellers of No. 2 fuel oil were quoting 4.6 cents per gallon at New York and some are asking 4¾ cents.

### Bunker C in Strong Position

Bunker C fuel continues to occupy its strong market position at $1.15 per barrel in New York. Marine consumption dropped last week, but adjustments of tonnage in foreign service are expected to revive this business as soon as mechanical requirements can be met.

Industrial consumption of residual fuel is reported at new peaks in this section of the country, and this is serving to offset the slump in deliveries to steamship lines. The tank-wagon market for residual fuel is firm at 3⅛ cents per gallon.

Domestic fuel-oil prices are expected to move forward before the month ends. Stocks of domestic burning oils are more than 2,000,000 bbl. lower than at the same time in 1938. Burner installations have been almost double so far this year over 1938. Refiners are showing a tendency to protect their light-fuel-oil stocks and are not anxious sellers at present prices.

Wax continues to be one of the outstanding products in this section of the country. Western Pennsylvania refiners raised their prices again last week, and those in position to accept business are currently asking 6½ cents for white crude scale at New York. Supplies are extremely difficult to locate, and the price appears to be a secondary consideration. The large milk distributors in New York started last week to make deliveries in paper containers requiring wax treatment. Most Pennsylvania refiners are unable to quote on new wax business. Some report their entire production for from 1 to 3 months is committed under contract and that they will be unable to quote for spot business during that period.

Prices for 65-octane and above gasoline were reported fairly well maintained in New York at 6½ cents per gallon. The Baltimore market for low-octane motor fuel was reported down a quarter of a cent to 6¼ cents. Prices were reported higher at Philadelphia and Norfolk for 72-74-octane gasoline. Most Philadelphia suppliers are currently quoting 6¾ cents for 72-74 material and at Norfolk the price generally quoted is 7¾ cents to the tank-car trade.

### Standard of Ohio Cuts Prices

Standard Oil Co. of Ohio cut service-station and tank-wagon prices in Cuyahoga County. The service-station price was dropped a cent and a half and the tank-wagon quotation was lowered a cent. Other retail markets in this section were unchanged. Since the market change was confined to a limited area, the Ohio change was considered here as meeting a local situation rather than demonstrative of basic weakness. Generally speaking, the motor-fuel market was considered fairly satisfactory in view of heavy stocks and the natural seasonal slump in motor-car operations.

The Pennsylvania lubricating-oil market continues unchanged. Refiners in most instances are restricting sales to limited quantities to contract customers only. Export inquiry remains brisk and there appears to be no prospect for a let-up in the record domestic demand. Bright stock of 25 pour test is quoted from 24½ to 33 cents, and 25-pour-test, 200-viscosity neutral oil ranges from 25 to 32 cents.

Tanker rates were unchanged last week. Owners are asking 33 to 35 cents for moving cargoes of heavy fuel from the Gulf to North Atlantic ports. The range for gasoline and light fuel oils runs from 31 to 35 or 36 cents.

Two boats were chartered for the Venezuela-to-north-of-Hatteras voyage last week at 31 cents per barrel, representing an advance of a cent over the previous high for the same trip. Tankers available for charter were reported scarce and owners are attempting to raise rates over the current quotations.

Fuel-oil imports may ease the pressure on the domestic refining industry to meet the winter demand. Consumption of light fuel oils has been running about 10 per cent greater this year than last and the last available data show stocks totaling 30,740,000 bbl., or 2,182,000 bbl. less than on hand at the same time last year. The possibility exists that in producing sufficient light fuel oil to meet demand this winter the gasoline inventory will grow disproportionately.

### Gulf Coast Markets

HOUSTON, Tex., Nov. 14.—Whatever further softness developed in gasolines in Gulf Coast refinery markets the past week was made up for in added strength in lubricating oils. No lubricating oils were available from any source, with the output of all plants completely sold up and sellers behind with their orders. The scarcity of coastal neutrals now is the most acute it has been in many years. Sellers reported turning down increasing numbers of inquiries.

Fuel and diesel oils maintained their strong positions. Suppliers said the colder weather that is sweeping many parts of the country will stir calls for burning oils from domestic consumers in addition to the heavy industrial requirements.

Further weakness was felt in motor fuels. Although sellers for the most part were slow to make further concessions in quotations, the appearance of a distress cargo of 74-octane leaded gasoline at a reported price offer as low as prevailing quotations for a 65-octane unleaded product was extremely disquieting. That the cargo went begging added to the concern, reflecting the complete lack of demand. This also gave further evidence that the present inactivity is not a matter of price.

Although kerosenes never are overplentiful on the Gulf Coast, buyers the past week found it a little easier to fill their wants.

Generally, the price structure was unchanged. There were frequent reports that certain refiners would take less than their quoted prices for gasoline if buyers were able to make certain and immediate shipment, but in the absence of important sales such reports were unsubstantiated. Higher-viscosity neutrals were advanced slightly with 1,200-viscosity pales moving at 9¾ to 10 cents and 2,000 pales at 10¼ cents.

## *A. P. I. Weekly Refinery Statistics*

**Week Ended November 11, 1939**

| | Capacity reporting (per cent) | Daily crude runs (bbl.) | Total gasoline stocks | Gas oil and fuel oil stocks |
|---|---|---|---|---|
| East Coast | 100.0 | 581,000 | 18,121,000 | 12,555,000 |
| Appalachian | 85.9 | 119,000 | 2,725,000 | 634,000 |
| Indiana, Illinois, and Kentucky | 90.2 | 541,000 | 10,796,000 | 6,821,000 |
| Oklahoma, Kansas, and Missouri | 81.6 | 255,000 | 6,120,000 | 4,552,000 |
| Inland Texas | 50.3 | 123,000 | 1,541,000 | 2,221,000 |
| Texas Gulf | 90.0 | 811,000 | 10,159,000 | 12,555,000 |
| Louisiana Gulf | 97.8 | 152,000 | 2,586,000 | 3,061,000 |
| North Louisiana and Arkansas | 55.0 | 46,000 | 332,000 | 890,000 |
| Rocky Mountains | 54.2 | 42,000 | 996,000 | 559,000 |
| California | 90.0 | 501,000 | 14,745,000 | 91,930,000 |
| Total reported | 86.2 | 3,171,000 | 68,121,000 | 135,778,000 |
| Estimated unreported | ..... | 365,000 | 5,150,000 | 3,205,000 |
| *Estimated total | ..... | 3,536,000 | 73,271,000 | 138,983,000 |
| *Estimated total previous week | ..... | 3,465,000 | 73,262,000 | 140,085,000 |
| *November 12, 1938 | ..... | 3,244,000 | 69,372,000 | 154,666,000 |

*Bureau of Mines, currently estimated.

## Stocks of Crude Oil in the United States

(BUREAU OF MINES ESTIMATE)

| | |
|---|---|
| Week ending October 28, 1939 | 230,994,000 barrels |
| Week ending October 21, 1939 | 230,453,000 barrels |
| Week ending October 29, 1938 | 275,217,000 barrels |

Figures do not include stocks of heavy, unrefinable California crude.

# Retail Oil Markets

Tank-wagon and filling station prices on gasoline and kerosene furnished by the larger marketing firms

Prices as of November 14, 1939

## Taxes

**The gasoline quotations given in the following tables include the 1-cent federal tax, as well as state, county, and city taxes. The gasoline is the regular or standard grade. In most areas lower grades and a premium grade also are available.**

## Standard Oil Co. (Indiana)

| | Gasoline Tank wag. | Gasoline Dlr. | Gasoline tax | Kero. Inc. tank wag. |
|---|---|---|---|---|
| Chicago, Ill. | 15.1 | 13.1 | 4.0 | 10.0 |
| Decatur | 15.1 | 12.1 | 4.0 | 8.5 |
| Joliet | 15.1 | 13.6 | 4.0 | 10.0 |
| Peoria | 15.1 | 13.6 | 4.0 | 10.0 |
| Quincy | 14.9 | 13.4 | 4.0 | 9.8 |
| Davenport, Ia. | 15.1 | 13.6 | 4.0 | ‡10.0 |
| Des Moines | 14.9 | 13.4 | 4.0 | ‡9.8 |
| Mason City | 15.3 | 13.8 | 4.0 | ‡10.2 |
| Duluth, Minn. | 16.9 | 15.4 | 5.0 | 10.8 |
| Mankato | 16.5 | 15.0 | 5.0 | 9.9 |
| Minneapolis | 16.5 | 15.0 | 5.0 | 10.4 |
| LaCrosse, Wis. | 16.5 | 15.0 | 5.0 | 10.4 |
| Green Bay | 16.9 | 15.4 | 5.0 | 10.0 |
| Milwaukee | 16.3 | 14.8 | 5.0 | 10.2 |
| Detroit, Mich. | 13.6 | 11.4 | 4.0 | 7.6 |
| Grand Rapids | 13.5 | 12.0 | 4.0 | 9.7 |
| Saginaw | 14.8 | 13.3 | 4.0 | 9.3 |
| Evansville, Ind. | 16.6 | 15.1 | 5.0 | †10.5 |
| Indianapolis | 16.8 | 15.3 | 5.0 | †10.7 |
| South Bend | 16.8 | 15.3 | 5.0 | †10.0 |
| Fargo, N. D. | 17.7 | 16.2 | 5.0 | 11.6 |
| Huron, S. D. | 17.0 | 15.5 | 5.0 | 10.9 |
| Kans. City, Mo.* | 14.4 | 12.9 | 4.0 | 8.0 |
| St. Louis* | 14.7 | 13.2 | 4.0 | 8.0 |
| St. Joseph | 14.4 | 12.9 | 4.0 | 7.9 |
| Wichita, Kans. | 13.3 | 10.6 | 4.0 | 7.4 |

*State tax 2 cents, 1-cent city tax and 1-cent federal tax. †Does not include 4-cent state tax. ‡Does not include 3-cent state tax.

Exclusive of state general sales taxes.

Discounts to commercial consumers: On purchases per month off tank-wagon prices: 1,000 gal. or more, 1.5 cents off; minimum delivery 25 gal.

## Stanolex Fuel Oil in Chicago

**Effective September 18, 1939, f.o.b. Chicago tank-wagon prices: Standard range oil, 1-99 gal., 9 cents; 100-149 gal., 8 cents; 150 gal. and over, 7.5 cents. Stanolex fuel oil No. 1, 1-149 gal., 8.25 cents; 150-399 gal., 7.25 cents; 400 gal. and over, 6.75 cents. Stanolex furnace oil, 1-149 gal., 8.25 cents; 150-399 gal., 7.25 cents; 400 gal. and over, 6.75 cents. Stanolex Grade A, 1-399 gal., 5.25 cents; 400 gal. and over, 4.25 cents. Stanolex Grade B, 1-799 gal., 5.25 cents; 800 gal. and over, 4.25 cents. Stanolex Grade C, 1-999 gal., 4.5 cents; 1,000 gal. and over, 3.5 cents.**

## Ohio

STANDARD OIL CO. OF OHIO

| | Gasoline Tank-wag. cons'r. | Gasoline Di-vided dlr. | Gasoline Inc. tax | Kero. tank wag. |
|---|---|---|---|---|
| Ohio points | 16.0 | 15.0 | 5.0 | *13.0 |

*Includes state tax of 1 cent.

## Atlantic Coast District

STANDARD OIL CO. OF NEW JERSEY

| | Gasoline Cons'r. tank car | Gasoline Dlr. tank wag. | Gasoline Inc. tax | Kero. tank wag. |
|---|---|---|---|---|
| Atl'tic City, N. J. | 11.6 | 12.7 | 4.0 | 7.60 |
| Newark | 11.6 | 12.7 | 4.0 | 7.60 |
| Annapolis, Md. | 13.35 | 14.35 | 5.0 | 9.5 |
| Baltimore | 12.75 | 13.75 | 5.0 | 7.5 |
| Cumberland | 14.15 | 16.15 | 5.0 | 10.0 |
| Wash'gton, D. C. | 11.00 | 12.0 | 3.0 | 9.5 |
| Danville, Va. | 14.95 | 17.45 | 6.0 | 12.9 |
| Norfolk | 13.75 | 16.25 | 6.0 | 11.0 |
| Petersburg | 14.05 | 16.55 | 6.0 | 11.7 |
| Richmond | 14.05 | 16.55 | 6.0 | 10.7 |
| Roanoke | 15.25 | 17.75 | 6.0 | 11.0 |
| Charles'n, W. Va. | 14.55 | 17.05 | 6.0 | 12.6 |
| Parkersburg | 13.85 | 15.35 | 6.0 | 11.2 |
| Wheeling | 14.85 | 16.75 | 6.0 | 12.2 |
| Charlotte, N. C. | 16.90 | 18.40 | 7.0 | 11.8 |
| Hickory | 17.45 | 18.95 | 7.0 | 12.3 |
| Mt. Airy | 17.30 | 18.80 | 7.0 | 12.2 |
| Raleigh | 16.65 | 18.15 | 7.0 | 11.5 |
| Salisbury | 16.95 | 18.45 | 7.0 | 11.9 |
| Charleston, S. C. | 14.75 | 17.25 | 7.0 | 10.6 |
| Columbia | 15.60 | 18.10 | 7.0 | 11.5 |
| Spartanburg | 16.30 | 18.80 | 7.0 | 12.2 |

**Price basis to Esselene undivided dealers: Dealer tank-wagon price less 0.5 cent per gallon. Price basis to commercial consumers, effective March 8, 1937, in Maryland, District of Columbia, and** in Arlington and Fairfax counties in Virginia; and March 12 in New Jersey: To contract accounts purchasing at least one full compartment at time by hose connection, on yearly purchases: From 2,500 to 100,000 gal., consumer tank-wagon price at time and place of delivery; 100,000 gal. per year, consumer tank-car price plus .5 cent per gallon. Consumer tank-wagon price generally will be equivalent to dealer tank-wagon price less .5 cent per gallon.

Effective January 16, 1939, in North Carolina the commercial consumer schedule became as follows: Single deliveries of 50 gal. or more, consumer tank-wagon price. Single deliveries of less than 50 gal., 4 cents per gallon over consumer tank-wagon price. Generally the posted consumer tank-wagon price will be equivalent to the dealer price, less .5 cent per gallon. The above policy also applies in South Carolina effective January 23, 1939.

Discounts for kerosene, 1 cent off tank-wagon price for 25 gal. or more under contract (contract not necessary in Baltimore) except no discount in New Jersey.

## Southern District

STANDARD OIL CO. (KENTUCKY)

| | Gasoline Cons'r. tank wag. | Gasoline Net dlr. | Gasoline Inc. tax | Kero. tank wag. |
|---|---|---|---|---|
| Atlanta, Ga. | 21.0 | 18.0 | 7.0 | 10.0 |
| Augusta | 20.0 | 17.5 | 7.0 | 10.0 |
| Macon | 21.0 | 18.0 | 7.0 | 10.5 |
| Savannah | 19.5 | 16.5 | 7.0 | 9.0 |
| Birmingham, Ala. | 21.5 | 18.5 | 8.0 | 9.0 |
| Mobile | 21.5 | 18.5 | 9.0 | 9.0 |
| Montgomery | 22.5 | 19.5 | 9.0 | 11.0 |
| Jackson, Miss. | 19.5 | 16.5 | 7.0 | 10.0 |
| Vicksburg | 19.5 | 16.5 | 7.0 | 9.5 |
| Jacksonville, Fla. | 19.0 | 16.0 | 8.0 | 8.0 |
| Miami | 19.5 | 16.5 | 8.0 | 7.0 |
| Pensacola | 21.5 | 18.5 | 9.0 | 8.5 |
| Tampa | 20.5 | 17.5 | 8.0 | 8.5 |
| Lexington, Ky. | 19.5 | 16.5 | 6.0 | 10.0 |
| Covington | 18.0 | 15.0 | 6.0 | 9.5 |
| Louisville | 18.5 | 15.5 | 6.0 | 9.0 |
| Paducah | 18.5 | 15.5 | 6.0 | 9.0 |

Price basis to tank-wagon consumers: Effective January 4, 1937; 3 cents per gallon below tank-wagon price.

Montgomery, Ala., has a county tax of 1 cent per gallon, and a city tax of 1 cent per gallon on gasoline, in addition to state tax and 1 cent per gallon on kerosene. Mobile, Ala., has a city gasoline tax of 2 cents per gallon; Birmingham, Ala., has a city gasoline tax of 1 cent per gallon; Pensacola, Fla., has a city gasoline tax of 1 cent. All are included in the table.

## Pennsylvania and Delaware

ATLANTIC REFINING CO.

| | Gasoline Cons'r. tank car | Gasoline Dlr. tank wag. | Gasoline Inc. tax | Kero. tank wag. |
|---|---|---|---|---|
| Philadelphia, Pa. | 12.0 | 13.5 | 5.0 | 10.0 |
| Pittsburgh | 13.0 | 14.5 | 5.0 | 10.5 |
| Allentown | 12.5 | 14.0 | 5.0 | 10.5 |
| Erie | 13.0 | 14.5 | 5.0 | 10.0 |
| Scranton* | 13.0 | 14.5 | 5.0 | 10.5 |
| Altoona | 13.0 | 15.0 | 5.0 | 10.5 |
| Dover, Del. | ... | 14.0 | 5.0 | 10.5 |
| Wilmington | ... | 13.5 | 5.0 | 9.75 |

Price basis to undivided dealers, dealer tank-wagon price less .5 cent per gallon.

*Voluntary discount of 1 cent allowed to dealers only.

Discount on kerosene, 2 cents per gallon off tank-wagon price on tank-wagon deliveries of 25 gal. or more at one time.

## Pacific Coast Territory

STANDARD OIL CO. OF CALIFORNIA

| | Gasoline Tank truck | Gasoline Serv. sta. | Gasoline Inc. tax | Kero. tank wag. |
|---|---|---|---|---|
| San Francisco | 17.5 | 18.5 | 4.0 | 11.5 |
| Los Angeles | 17.0 | 18.0 | 4.0 | 10.0 |
| Fresno, Calif. | 18.5 | 19.5 | 4.0 | 12.5 |
| Phoenix, Ariz. | 20.0 | 21.0 | 6.0 | *17.5 |
| Reno, Nev. | 20.5 | 21.5 | 5.0 | 13.5 |
| Portland, Ore. | 20.0 | 21.0 | 6.0 | 13.5 |
| Seattle, Wash. | 20.0 | 21.0 | 6.0 | †13.75 |
| Spokane | 21.5 | 22.5 | 6.0 | †16.75 |
| Tacoma | 20.0 | 21.0 | 6.0 | †13.75 |

*Includes 5-cent state tax. †Includes 0.25-cent state tax.

Discounts to dealers: On gasoline, off tank-wagon price, to 100 per cent dealers, 3 cents. To commercial consumers: On tank-wagon price; on single deliveries of 40 gal. and over, advance quantity discount extended at time of delivery, 3 cents. Service-station schedule applies on single deliveries less than 40 gal. On kerosene in tank-car, transport-truck and trailer delivery, 3 cents off tank-wagon price; plant deliveries to jobbers, 2.5 cents below tank wagon.

March 18, 1939, split dealer discount was canceled.

## New York and New England

SOCONY-VACUUM OIL CO., INC.

| | Gasoline Cons'r. tank car | Gasoline Dlr. tank wag. | Gasoline Inc. tax | Kero. tank wag. |
|---|---|---|---|---|
| Albany | 12.5 | 14.0 | 5.0 | 7.80 |
| *Met. N. Y.: | | | | |
| Manhat., Bronx | 12.6 | 13.4 | 5.0 | 8.00 |
| Queens, Br'klyn | 12.6 | 13.4 | 5.0 | 8.00 |
| Staten Island | 12.6 | 13.4 | 5.0 | 8.00 |
| Buffalo | 13.1 | 14.5 | 5.0 | 7.70 |
| Rochester | 13.3 | 14.0 | 5.0 | 8.30 |
| Syracuse | 13.1 | 14.5 | 5.0 | 8.30 |
| Boston | 11.4 | 13.0 | 4.0 | 8.00 |
| Portland, Me. | 12.5 | 14.3 | 5.0 | 8.00 |
| Manchester, N.H. | 13.2 | 15.0 | 5.0 | 8.40 |
| Burlington, Vt. | 13.0 | 15.2 | 5.0 | 8.20 |
| Springfield, Mass. | 12.1 | 13.5 | 4.0 | 8.20 |
| Worcester | 12.0 | 13.5 | 4.0 | 8.20 |
| Hartford, Conn. | 11.8 | 13.3 | 4.0 | 7.90 |
| New Haven | 11.7 | 12.8 | 4.0 | 8.00 |
| Providence, R. I. | 11.4 | 13.3 | 4.0 | 8.00 |

*Does not include 2 per cent city sales tax, which is calculated on basis of net retail price exclusive of state and federal taxes. Metropolitan New York prices are undivided dealer prices; others are split dealer.

Effective February 15, 1939, the company changed its commercial consumer policy in New York and New England points for tank-wagon delivery to the following: Annual purchases 10,000 gal. and under, tank-car price plus 2 cents per gallon; annual purchases 10,000 gal. up to 50,000 gal., tank-car price plus 1.5 cents per gallon; annual purchases 50,000 to 200,000 gal., tank-car price plus 1 cent per gallon; annual purchases 200,000 gal. and over, tank-car price plus ½ cent per gallon. Private consumers pay undivided dealer price, plus 2 cents per gallon. Private consumers receiving full compartment deliveries of at least 200 gal. receive a discount of ½ cent per gallon.

## Rocky Mountain District

CONTINENTAL OIL CO.

| | Gasoline Tank wag. | Gasoline Dlr. | Gasoline Incl. tax | Kero. tank wag. |
|---|---|---|---|---|
| Denver, Colo. | 15.5 | ... | 5.0 | 11.5 |
| Grand Junction | 18.5 | ... | 5.0 | 15.0 |
| Pueblo | 16.0 | ... | 5.0 | 9.0 |
| Casper, Wyo. | 17.5 | ... | 5.0 | 11.5 |
| Cheyenne | 15.5 | ... | 5.0 | 13.0 |
| Billings, Mont. | 18.5 | ... | 6.0 | 13.0 |
| Butte | 20.0 | ... | 6.0 | 15.5 |
| Great Falls | 19.5 | ... | 6.0 | 15.5 |
| Helena | 20.5 | ... | 6.0 | 15.5 |
| Salt Lake, Utah | 17.5 | 17.5 | 5.0 | 16.0 |
| Boise, Idaho | 21.1 | 21.1 | 6.0 | 18.0 |
| Twin Falls | 21.1 | 21.1 | 6.0 | 18.0 |
| Albu'que, N. M. | 17.0 | 17.0 | 6.5 | 10.0 |
| Roswell | 15.5 | 15.5 | 6.5 | 8.0 |
| Santa Fe | 17.5 | 17.5 | 6.5 | 10.0 |

*Includes city tax of 0.5 cent. †Includes state tax of 1 mill.

Tank wagon represents price to consumers. Dealer represents price to dealers. If no dealer price is quoted, the tank-wagon price applies to all classes of trade.

## Central South District

STANDARD OIL CO. OF LOUISIANA

| | Gasoline Cons. tank car | Gasoline Dlr. tank wag. | Gasoline Inc. tax | Kero. tank wag. |
|---|---|---|---|---|
| New Orleans, La. | 15.25 | 17.75 | 8.0 | †11.0 |
| Baton Rouge | 15.25 | 17.75 | 8.0 | ‡10.5 |
| Alexandria | 15.25 | 17.75 | 8.0 | ‡12.5 |
| Lafayette | 15.00 | 18.00 | 8.0 | ‡11.0 |
| Lake Charles | 15.25 | 17.75 | 8.0 | ‡12.5 |
| Shreveport | 14.00 | 16.50 | 8.0 | ‡11.0 |
| Knoxville, Tenn. | 18.50 | 21.00 | 8.0 | 13.0 |
| Memphis | 16.50 | 19.00 | 8.0 | 11.0 |
| Chattanooga | 18.00 | 20.00 | 8.0 | 12.0 |
| Nashville | 17.50 | 20.00 | 8.0 | 11.0 |
| Bristol | 18.75 | 20.00 | 8.0 | 13.0 |

Esselene at dealer price less 0.5 cent per gallon to undivided dealers.

†Includes 1-cent parish tax and 1-cent state tax. ‡Includes 1-cent state tax.

Price basis to commercial consumers: Effective May 15, 1937, deliveries of 50 gal. or more in one territory take posted consumer tank-wagon price. Accounts taking deliveries of less than 50 gal. at one time pay posted consumer tank-wagon price plus 4 cents per gallon. Generally, the posted consumer tank-wagon price will be equivalent to the dealer price less 0.5 cent per gallon. Kerosene prices include 1-cent state tax.

Effective February 24, 1939, the company reestablished in New Orleans the commercial consumer policy on motor fuel effective in the rest of the state.

Effective December 12, 1938, the company revised its commercial consumer policy on motor fuel in New Orleans, as follows: Single deliveries of less than 50 gal., consumer tank car plus 2 cents per gallon 50 to 199 gal., consumer tank car plus 1 cent per gallon; 200 gal. and over, consumer tank car plus 0.5 cent per gallon.

## Nebraska

STANDARD OIL CO. (NEBRASKA)

| | Gasoline Tank wag. | Gasoline Dlr. | Gasoline Inc. tax | Kero. tank wag. |
|---|---|---|---|---|
| Omaha | 16.9 | 13.9 | 6.0 | 9.8 |
| McCook | 16.5 | 14.4 | 6.0 | 9.0 |
| Norfolk | 17.3 | 15.8 | 6.0 | 9.5 |
| North Platte | 17.8 | 16.3 | 6.0 | 10.0 |
| Scottsbluff | 18.5 | 15.5 | 6.0 | 11.4 |

Discounts to commercial consumers for tank-wagon deliveries covered only by standard commercial consumers contract, effective January 1, 1935.

## Oklahoma and Arkansas

CONTINENTAL OIL CO.

| | Gasoline Tank-wg. dlr. | Gasoline Includes tax | Kero. tank wag. |
|---|---|---|---|
| Texarkana, Ark. | 14.0 | 5.0 | 8.0 |
| Fort Smith | 14.5 | 5.0 | 7.5 |
| Little Rock | 17.25 | 7.5 | 8.0 |
| Muskogee, Okla. | 12.0 | 5.0 | 7.0 |
| Oklahoma City | 11.0 | 5.0 | 6.5 |
| Tulsa | 12.0 | 5.0 | 7.5 |

The tank-wagon price is the price to all classes of trade.

## Texas

| | Gasoline Tank wag. | Gasoline Serv. sta. | Gasoline Inc. tax | Kero. tank wag. |
|---|---|---|---|---|
| Dallas, Tex. | 12.0 | 16.0 | 5.0 | 7.0 |
| Fort Worth | 15.0 | 19.0 | 5.0 | 8.0 |
| Houston | 14.0 | 18.0 | 5.0 | 8.0 |
| San Antonio | 14.0 | 18.0 | 5.0 | 8.0 |

## Canada

3-Star Imperial Gasoline
IMPERIAL OIL, LTD.

| | Tank wag. | Inc. tax | Kero. tank wag. |
|---|---|---|---|
| Halifax, N. S. | 24.5 | 10.0 | 18.5 |
| St. John, N. B. | 24.5 | 10.0 | 18.5 |
| Montreal, Que. | 23.0 | 8.0 | 15.5 |
| Toronto, Ont. | 23.5 | 8.0 | 16.0 |
| Hamilton, Ont. | 23.5 | 8.0 | 16.0 |
| Winnipeg, Man. | 26.5 | 7.0 | 20.5 |
| Brandon, Man. | 25.0 | 7.0 | 22.9 |
| Regina, Sask. | 25.5 | 7.0 | 20.5 |
| Saskatoon, Sask. | 25.0 | 7.0 | 23.0 |
| Edmonton, Alta. | 25.9 | 7.0 | 20.9 |
| Calgary, Alta. | 23.0 | 7.0 | 18.0 |
| Vancouver, B. C. | 23.0 | 7.0 | 23.0 |

*Imperial gallon used in Canada.

Divided dealers pay tank-wagon prices. Discount to undivided dealers, 1 cent below tank-wagon price. In maritime provinces both divided and undivided dealers pay tank-wagon price.

## Naphtha

STANDARD OIL CO. (INDIANA)

| | Tank wagon* |
|---|---|
| Oleum spirits | 15.7 |
| V.M.&P. naphtha | 16.0 |
| Cleaners' naphtha | 15.0 |
| Stanisol | 15.0 |

*Prices include 3-cent Illinois tax but not 1-cent federal tax nor 2 per cent retail occupational tax.

Prices f.o.b. Chicago. Each price subject to discount of 1 cent per gallon for 150-gal. lots if covered by contract.

## Tank-Wagon Changes

Standard Oil Co. (Indiana) October 31 reduced dealer gasoline 0.7 cent in Detroit; November 4, advanced tank-wagon kerosene 0.5 cent in Mankato.

Standard Oil Co. of Nebraska November 7 reduced dealer gasoline 0.3 cent in Omaha; November 9, made further reduction of 1 cent.

Standard Oil Co. (Kentucky) October 24 advanced consumer tank-wagon and dealer gasoline 1 cent in Atlanta; same date, reduced tank-wagon kerosene 0.5 cent in Jacksonville.

Standard Oil Co. (Indiana) November 15 advanced tank-car and tank-wagon prices on all grades of naphtha, except Stanolind stove and lighting naphtha 0.5 cent in Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Kansas, North Dakota, South Dakota, and Wisconsin.

# Prices of Refined Products

All quotations f.o.b. plant in cars for interstate or export movement except as otherwise noted

Prices as of November 14, 1939

The following quotations are exclusive of the federal excise taxes of 1 cent a gallon on gasoline and 4 cents a gallon on lubricating oils.

## Refinery Gasoline

**OKLAHOMA (Group 3)—**

U. S. Motor grades:
62 octane and below .04¼ .04⅝
63-66 octane .04½ .04⅝
67-69 octane .04⅝ .04¾
70-72 octane (regular) .05 .05⅛
60-62 400 grades:
62 octane and below .04¼ .04⅜
63-66 octane .04½ .04⅝
67-69 octane .04⅝ .04¾
70-72 octane (regular) .05 .05⅛
68-70 360 .05 .05⅛

**NORTH TEXAS—**

U. S. Motor grades:
62 octane and below .04¼ .04⅜
63-66 octane .04½ .04⅝
67-69 octane .04⅝ .04¾
70-72 octane (regular) .05 .05⅛
60-62 400 .04¼ .04⅜

**NORTH LOUISIANA (Ark. and N. La. delivery)—**

U. S. Motor grades:
62 octane and below .04⅝ .04¾
63-66 octane .04⅝ .05⅛
67-69 octane .05¼ .05⅛
70-72 octane (regular) .05¾

**ARKANSAS (Ark. and N. La. del.)—**

U. S. Motor grades:
62 octane and below .04¾
67-69 octane no quotations
70-72 octane (regular) .05¼

**CHICAGO (Based on Group 3)—**

U. S. Motor grades:
62 octane and below .04½ .04⅝
63-66 octane .04¾ .04⅞
67-69 octane .05 .05⅛
70-72 octane (regular) .05⅛ .05⅝
60-62 400 grades:
62 octane and below .04½ .04⅝
63-66 octane .04¾ .04⅞
67-69 octane .05 .05⅛
70-72 octane (regular) .05⅛ .05⅝
68-70 360 .05 .05⅛

**PENNSYLVANIA (Inland refineries)—**

58-60 U. S. Motor .05
65 octane .06⅜ .06⅝
72-24 octane (regular) .06½ .06¾

**CALIFORNIA (domestic movement)—**

54-58 U. S. Motor .06¼ .08
58-60 400, 65 oct. and higher .07¼ .09

**EAST COAST (domestic)—**

U. S. Motor, 65 and above:
*New York (Bayonne) .06½ .06⅝
Philadelphia .06¼ .06⅜
Baltimore .06¼ .06¾
Charleston, S. C. .06¾ .07

*All grades of gasoline ⅛ to ¼ cent less for barge shipments. New York Harbor prices are for New York and New England delivery. Prices for New Jersey delivery ¼ cent lower.

**GULF COAST (domestic)—**

U. S. Motor grades:
Below 60 octane .05½ .05⅝
65-67 octane .05⅝ .06
68-70 octane .06 .06¼

## Natural Gasoline

**OKLAHOMA (Group 3)—**

Grade 26-70 .04¼
Grade 18-55 .05 .05⅛

**NORTH TEXAS—**

Grade 26-70 .04
Grade 18-55 .04¾

**CALIFORNIA—**

75-85 375-390 .05½ .06¼

**NORTH LOUISIANA (Ark. and N. La. delivery)—**

Grade 26-70 .04⅝

## Tractor Fuel

**OKLAHOMA (Group 3)—**

40-42 gr., 315-325 i.b.p., 110-flash, 540-550 e.p. .03½ .03¾
41-43 gr., 300-320 i.b.p., 110-125 flash, 500-520 e.p. .03⅝ .03¾
46-48 gr., 210-230 i.b.p., 480-max., e.p. .03⅞ .04⅛

## Kerosene

(All kerosene water white)

**OKLAHOMA (Group 3)—**

41-43 .03⅝ .03¾
42-44 .03¾ .03⅞

**NORTH TEXAS—**

41-43 .03⅝ .03¾

**NORTH LOUISIANA (Ark. and N. La. delivery)—**

41-43 .03½ .03⅝

**ARKANSAS (Ark. and N. La. del.)—**

41-43 .03⅝

**PENNSYLVANIA (Inland refineries)—**

45 .04¾ .05
46 .05⅛ .05⅜
47 .05 .05¼

**CHICAGO (Based on Group 3)—**

41-43 .03⅝ .03¾
42-44 .03¾ .03⅞

**CALIFORNIA (Pac. Coast market)—**

38-43 high burning test .04¾ .05¾

**NEW YORK (Bayonne, N. J.)—**

41-43 .04⅞ .05

***GULF COAST (domestic)—**

41-43 .04½ .04¾

*Barge price ⅛ cent lower.

## Furnace Oil

**OKLAHOMA (Group 3)—**

Range oil .03½ .03⅝
No. 1 prime white, 38-42 .03½ .03⅝
No. 1 straw, 38-40 .03⅝ .03½
No. 2 straw, 32-36 .03¾ .03⅝
No. 2 dark, 32-36 .03½ .03¼
No. 3 zero to 15, 28-32 .03 .03⅛
No. 3, 15 and above, 28-32 .02¾ .03

**NORTH TEXAS—**

No. 1 prime white, 38-42 .03½ .03⅝
No. 1 straw, 38-40 .03⅝ .03½

**NORTH LOUISIANA (Ark. and N. La. delivery)—**

No. 2, 32-36 .03 .03⅛

**ARKANSAS (Ark. and N. La. del.)—**

No. 2, 32-36 .03¼

**CHICAGO (Based on Group 3)—**

Range oil .03½ .03⅝
No. 1 prime white, 38-40 .03½ .03⅝
No. 1 straw, 38-40 .03⅝ .03½
No. 2 straw, 32-36 .03¼ .03⅜
No. 2 dark, 32-36 .03⅛ .03⅜
No. 3, zero to 15, 28-32 .03¼ .03¼
No. 3, 15 and above, 28-32 .02¾ .03

**NEW YORK (Bayonne, N. J.)—**

*No. 1 .04⅝ .05
*No. 2 .04⅝ .04½
*No. 4 .04¼ .04½

*Barge deliveries ⅛ to ¼ cent under above tank-car price.

## Gas Oil and Fuel Oil

(Gas oil per gal., fuel oil per bbl.)

**OKLAHOMA (Group 3)—**

U.G.I. gas oil, under 35 .02⅝ .02¾
No. 5, low pour point, 18-22 .70 .75
Below 14 fuel oil, industrial .50 .55

**NORTH TEXAS—**

U.G.I. gas oil, under 35 .02⅝ .02¾
No. 5, low pour point, 18-22 .70 .75
Below 14 fuel oil, industrial .50 .55

**NORTH LOUISIANA (Ark. and N. La. delivery)—**

10-14 fuel oil, industrial .70 .75

**CHICAGO (Based on Group 3)—**

U.G.I. gas oil .02⅝ .02⅞
No. 5, low pour point, 18-22 .70 .80
No. 5, 15 and above, 18-22 .60 .70
No. 6, low pour point, 10-16 .60 .70
No. 6, 15 and above, 10-16 .45 .50

**PENNSYLVANIA (Inland refineries)—**

36-40 .04⅛ .04½

**CALIFORNIA—**

Los Angeles:
30-40 gas oil, per bbl. 1.15 1.30
24 plus diesel, per bbl. 1.00 1.30
24 plus diesel (bunkers) 1.30 1.40
12-16 (bunkers at tidewater) .70 .90
10-16 (cargo lots) .65 .75
12-17 (tank cars) .60 .85
10-17 (high sulfur) .50 .70
San Joaquin Valley:
10-18 (tank cars) .55 .75
24 plus diesel, per bbl. 1.00 1.25
San Francisco:
24 plus diesel, per bbl. 1.45 1.50
24 plus diesel (bunkers) 1.55 1.60
10-16 (bunkers) .90 .95

**GULF COAST—**

No. 2 fuel .04¼
43-47 diesel .04
48-52 diesel .04¼
53-57 diesel .04½
58 and above diesel .04¾
Bunker C (bulk cargoes) .95 1.00
Bunker C (bunkers) .95 1.00

**NEW YORK (Bayonne, N. J.)—**

27 plus, gas oil .04¼
28-30 diesel (lighterage 6¼c per bbl.) 1.75
28-30 diesel (tank cars) .04¼
Bunker C (to ocean-going ships in N. Y. Harbor) 1.15
Industrial fuel (tank cars) .04

Lighterage charge 5c bbl. additional.

## Bright and Steam Refined

**OKLAHOMA (Group 3)—**

190-200 D, 15-25 .27
150-160 D, 0-10 .24
150-160 D, 15-25 .23
150-160 E, 15-25 .23
100-110 D, 0-10 .23
Steam refined:
600 dark green (untreated) .08

**PENNSYLVANIA—**

Bright Stocks (Pennsylvania Grade No. 8 color, 140-150 at 210, 545-550 flash):
10 pour point .29 .33
15 pour point .28 .32
25 pour point .24½ .30
Steam refined:
600 .14½ .17
650 .16 .20
600 flash .16½ .21
630 flash .20 .24

## Neutral Oil

(Vis. at 100° F. except Pennsylvania and color N.G.A.)

**OKLAHOMA (Group 3)—**

0-10 pour point:
150-3 .13
180-3 .14
180-4 .13½
200-3 .14½
200-4 .14
250-3 .16
250-4 .15½
280-3 .17
280-4 .16½
300-3½ .17½
400-3½ .18½
100-2½ paraffin oil .07½
15-25 pour point:
200-3 .14
200-4 .13½
250-3 .15
250-4 .14½
280-3 .16½
280-4 .16

**GULF COAST—**

Pale oils:
200-3 .07 .07½
300-3 .07¾ .08
500-3½ .08½ .09
750-3½ .09 .09½
1,200-3½ .09¾ .10
2,000-4 .10¼
Red oils:
200-5-6 .06¾ .07¼
300-5-6 .07½ .07¾
500-5-6 .08¼ .08¾
750 .08¾ .09¼
1,200-5-6 .09¾ .09⅝

**CALIFORNIA (moving to dom. market)—**

Pale oils:
100-2½-3 .07¼ .08
200-2½-3 .07¼ .08
300-2½-3 .07¼ .08
400-3-4 .07¼ .08
450-3-4 .07¼ .08
550-3-4 .09 .11
600-3-4 .09 .11
Red oils:
200-4-5 .07¼ .08
300-5-6 .07¼ .08
350-5-6 .09¼ .11½
400-5-6 .09¼ .11½
450-5-6 .09¼ .11½
500-5-6 .09¼ .11½
600-5-6½ .09¼ .11½
700-6½ plus .09¼ .11½
750-6½ plus .09¼ .11½
900-6½ plus .09¼ .11⅛

**PENNSYLVANIA—**

150 vis. at 70° F., 3 color, 400-405 flash:
Zero pour point .31 .32
10 pour point .30 .31
15 pour point .29 .30
25 pour point .23 .28
200 vis. at 70° F., 3 color:
Zero pour point .33 .34
10 pour point .32 .33
15 pour point .31 .32
25 pour point .25 .32

## Wax and Petrolatum

(Prices per pound)

**OKLAHOMA (Group 3)—**

124-126 (A.m.p.) w.c. scale .0625 .0650

**PENNSYLVANIA (Inland refineries)—**

122-124 (A.m.p.) w.c. scale .0650
124-126 (A.m.p.) w.c. scale .0650

**NEW YORK—**

Wax in bags fully refined:
123-125 (A.m.p.) wax .0505
125-127 (A.m.p.) wax .0520
128-130 (A.m.p.) wax .0560
130-132 (A.m.p.) wax .0585
133-135 (A.m.p.) wax .0615
135-137 (A.m.p.) wax .0640
Crude scale:
124-126 (A.m.p.) w.s. .0600
124-126 (A.m.p.) y.s. .0575
Petrolatum in barrels, carload lots:
Dark green .03½
Amber .03⅝
Extra amber .04
Lily white .06½
Snow white .07⅝
Cream .05½

## Export Prices

### GASOLINE

**GULF COAST—**

U. S. Motor .05 .05¼
60-62 400 .05½ .06
65 octane .06¼ .06½
68 octane .06¾ .07
70 octane .07 .07¼

**LOS ANGELES—**

U. S. Motor grades:
60-65 octane .05½ .05¾
65-69 octane .05¾ .06¼
Above 69 octane .06¼ .06½

### KEROSENE

**GULF COAST—**

41-43 prime white .05¼
41-43 water white .05¼

**LOS ANGELES—**

41-43 water white .05 .05¼

### LUBRICANTS

(Pennsylvania Grade)

**NEW YORK (f.o.s.) in bbls.—**

Cylinder stocks:
600 S.R. unfiltered .25 .26½
650 S.R. unfiltered .27 .28½
600 flash, S.R. .28 .30½
630 flash, S.R. .30 .34
Bright stock:
8 color .40 .42

### NEUTRAL OIL

200-3 color .38 .43
150-3 color .37 .40

### PARAFFIN WAX

**NEW YORK (prices per pound)—**

123-125 A.m.p. .0505
125-127 A.m.p. .0650
128-130 A.m.p. .0675
133-135 A.m.p. .0750
135-137 A.m.p. .0850
Crude scale:
122-124 w.s. .0600
124-126 w.s. .0600
122-124 y.s. .0575
124-126 y.s. .0575

# Market Record of Active Oil Stocks

Compiled by Carl H. Pforzheimer & Co., 25 Broad Street, New York City, Member New York Stock Exchange and New York Curb Exchange

## New York Stock Exchange

| 1939 High | 1939 Low | Week ended Nov. 10 High | Week ended Nov. 10 Low | Week ended Nov. 10 Close | Stocks— | Total shares outstanding | Par value | Latest dividend | Payable or last paid | Dividends paid in 1938 | Com. sh. earn. 1938 | Com. sh. earn. 1937 | 1938 High | 1938 Low | 1937 High | 1937 Low |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 74½ | 50 | 64¼ | 62 | 62 | Amerada Corp. | 788,675 | N.P. | 50cQ | 10-31-39 | $2.00 | $2.07 | $3.04 | 78 | 55 | 111⅞ | 51½ |
| 24⅞ | 18⅛ | 24¼ | 23 | 23½ | Atlantic Refining | 2,663,999 | $25 | 25cQ | 12-15-39 | 1.00 | 1.40 | 3.51 | 27⅝ | 17¾ | 37 | 18 |
| 21½ | 10¼ | 17⅜ | 15⅞ | 16⅛ | Barber Asphalt Co. | 390,223 | $10 | 75c | 12-16-37 | .... | —.85 | 1.91 | 23¾ | 12⅛ | 43⅜ | 10⅛ |
| 19½ | 11⅛ | 15 | 14⅛ | 14⅜ | Barnsdall Oil Co. | 2,250,344 | $5 | 15c | 12-9-39 | 1.00 | 1.26 | .85 | 21⅜ | 10⅛ | 35¼ | 10 |
| 9⅞ | 6½ | 8¼ | 7¾ | 7⅞ | Consolidated Oil Corp. | 13,751,846 | N.P. | 20cQ | 11-15-39 | .80 | .55 | 1.48 | 10¾ | 7 | 17⅜ | 7 |
| 31½ | 19⅞ | 27 | 25 | 25½ | Continental Oil of Delaware | 4,682,581 | $5 | 25cQ | 9-28-39 | ‖1.00 | 1.10 | 2.98 | 35¾ | 21¼ | 49 | 24 |
| 9⅜ | 4½ | 7⅜ | 6⅝ | 6¾ | Houston Oil (new) | 1,098,618 | $25 | .... | 10-17-30 | .... | .83 | .94 | 9¾ | 5 | 17⅝ | 4¾ |
| 20¼ | 10 | 14⅝ | 14¼ | 14¼ | Lion Oil Refining | 435,815 | N.P. | 25cQ | 10-10-39 | 1.00 | 2.09 | 2.17 | 25⅛ | 15⅝ | 34 | 12½ |
| 18 | 11⅛ | 16 | 14¾ | 15 | Mid-Continent Petroleum | 1,857,912 | $10 | 35c | 12-1-39 | .60 | .56 | 2.86 | 22⅝ | 12¼ | 35⅜ | 14 |
| 14⅞ | 8¾ | 10¼ | 10 | 10 | Mission Corporation | 1,379,245 | $10 | 25c | 6-29-39 | 1.00 | 1.04 | 1.31 | 17¾ | 10⅝ | 34 | 15 |
| 15½ | 5⅝ | 10¾ | 9½ | 9¾ | National Supply | 1,155,517 | $10 | .... | 12-22-37 | .... | —.79 | 4.90 | 23 | 12½ | 41⅜ | 17⅝ |
| 10½ | 6 | 8¼ | 7⅜ | 7½ | Ohio Oil Co. | 6,563,377 | N.P. | 20c | 12-15-38 | .20 | .25 | 1.30 | 14⅞ | 8⅞ | 22⅞ | 8 |
| 11⅞ | 7⅜ | 8¼ | 8¼ | 8¼ | Pacific Western Oil | 1,000,000 | N.P. | 50c | 12-20-38 | .50 | 1.22 | 1.39 | 15⅞ | 10¼ | 29¾ | 11¾ |
| 8¾ | 5 | 6⅝ | 6½ | 6½ | Pan American Pet. & Trans. | 4,702,945 | $5 | .... | 12-21-37 | .... | .08 | 1.18 | 9¼ | 6¼ | 17⅛ | 7 |
| 46½ | 31¼ | 42⅞ | 41 | 41⅜ | Phillips Petroleum | 4,449,052 | N.P. | 50cQ | 12-1-39 | ‖2.00 | 2.03 | 5.42 | 44⅜ | 27¼ | 64 | 30½ |
| 24 | 17⅛ | 22⅞ | 21¾ | 21¾ | Plymouth Oil Co. | 1,006,200 | $5 | 35cQ‡ | 12-31-39 | 1.40 | 2.59 | 2.85 | 25⅜ | 15 | 29⅞ | 13 |
| 11¾ | 6⅛ | 9 | 8½ | 8½ | Pure Oil Co. | 3,982,031 | N.P. | 25c | 12-1-37 | .... | .38 | 2.15 | 13½ | 8¼ | 24⅜ | 8¾ |
| 10¼ | 6⅝ | 9¼ | 8⅝ | 9 | Richfield Oil Corp. | 4,010,000 | N.P. | 50c | 12-21-38 | .50 | .51 | .35 | 9⅞ | 5 | 6½ | 4½ |
| 24⅜ | 15½ | 21 | 20½ | 20½ | Seaboard Oil of Delaware | 1,244,383 | N.P. | 25cQ | 12-15-39 | 1.00 | 1.52 | 1.97 | 27½ | 15½ | 54⅛ | 16 |
| 17¼ | 9⅞ | 14½ | 12¾ | 13 | Shell Union Oil | 13,070,625 | N.P. | 25c | 7-20-39 | .70 | .72 | 1.44 | 18⅜ | 10 | 34⅜ | 14⅞ |
| 29½ | 15½ | 22 | 20¾ | 21¼ | Skelly Oil | 995,349 | $15 | 50c | 11-15-39 | 1.00 | 2.27 | 6.07 | 34¾ | 18½ | 60⅝ | 26½ |
| 15⅛ | 10¼ | 13¾ | 13 | 13 | Socony-Vacuum | 31,206,071 | $15 | 25cSA | 9-15-39 | .50 | 1.29 | 1.82 | 16⅜ | 10¾ | 23¼ | 13 |
| 33⅝ | 24¼ | 28¼ | 26¾ | 27¼ | Standard Oil of California | 13,004,153 | N.P. | 25cQ | 12-15-39 | 1.40 | 2.22 | 3.17 | 34⅞ | 25⅛ | 50 | 27½ |
| 30 | 22¾ | 27¾ | 27 | 27⅝ | Standard Oil (Indiana) | 15,272,020 | $25 | 50c† | 12-15-39 | 1.00 | 1.82 | 3.66 | 35½ | 24¾ | 50 | 26½ |
| 53½ | 38 | 48½ | 47⅜ | 47½ | Standard Oil of New Jersey | 26,618,065 | $25 | 75c¶ | 12-15-39 | §1.50 | 2.86 | 5.64 | 58⅜ | 39¾ | 76 | 42 |
| 66 | 45¾ | 59½ | 58¾ | 58¾ | Sun Oil | 2,316,484 | N.P. | 25cQ | 12-15-39 | 1.00 | 1.07 | 3.86 | 65⅛ | 45 | 77½ | 44½ |
| 3⅝ | 1⅜ | 3 | 2⅜ | 2⅜ | Superior Oil Corp. | 1,388,979 | $1 | 10c | 12-28-38 | .10 | .24 | .32 | 4¼ | 1⅜ | 7⅜ | 1½ |
| 50¾ | 32½ | 47⅝ | 46⅛ | 46½ | Texas Corp. | 10,876,882 | $25 | 50cQ | 10-2-39 | 2.00 | 2.13 | 5.02 | 49⅝ | 32⅝ | 65⅛ | 34⅜ |
| 5⅜ | 3¼ | 4⅝ | 4¼ | 4¼ | Texas Gulf Producing Co. | 888,144 | N.P. | 10c | 12-15-39 | .15 | .86 | .68 | 5⅞ | 2⅝ | 9⅝ | 2 |
| 11⅜ | 7 | 9½ | 9⅛ | 9⅛ | Texas Pacific Coal & Oil | 888,236 | $10 | 10c | 12-1-39 | .40 | 1.16 | 1.11 | 12½ | 7 | 16⅝ | 5⅜ |
| 14¼ | 9½ | 11⅞ | 11 | 11 | Tide Water Associated | 6,375,253 | $10 | 15c | 12-1-39 | 1.00 | 1.28 | 2.08 | 15¾ | 10⅛ | 21⅝ | 13⅛ |
| 19¾ | 15⅛ | 17⅞ | 16⅝ | 17¾ | Union Oil of California | 4,666,270 | $25 | 25c | 11-10-39 | 1.20 | 1.47 | 2.58 | 22½ | 17⅛ | 28⅛ | 17½ |
| 24¼ | 20⅛ | 23¼ | 22⅞ | 23¼ | Union Tank Car Co. | 1,177,381 | N.P. | 40c† | 12-1-39 | 1.30 | 1.16 | 1.70 | 23½ | 20 | 31½ | 22 |
| 4¼ | 2⅜ | 4 | 3⅝ | 3¾ | Wilcox Oil & Gas | 487,568 | $5 | .... | 5-10-28 | | .52 | .24 | 3½ | 1⅝ | 6¼ | 1¾ |

†Includes extras. ‡Also 2 per cent in stock. §Also 1½ per cent stock dividend. ‖Also right to subscribe to bonds. ¶Also 1½ per cent in stock. —Deficit.

## New York Curb Exchange

| 1939 High | 1939 Low | Week ended Nov. 10 High | Week ended Nov. 10 Low | Week ended Nov. 10 Close | Stocks— | Total shares outstanding | Par value | Latest dividend | Payable or last paid | Dividends paid in 1938 | Com. sh. earn. 1938 | Com. sh. earn. 1937 | 1938 High | 1938 Low | 1937 High | 1937 Low |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11¾ | 5½ | 7½ | 6¾ | 6¾ | American Republics Corp. | 1,308,049 | $10 | 10c | 7-11-38 | $0.10 | —$0.22 | $0.27 | 11¾ | 5 | 10 | 6⅝ |
| 7¼ | 2½ | 3¾ | 3¼ | 3¼ | Bridgeport Machine Co. | 270,000 | N.P. | $1.25 | 12-30-37 | .... | —.14 | 1.90 | 10¼ | 4⅞ | 21⅜ | 7 |
| 34⅝ | 26½ | 32 | 29⅝ | 30¼ | Buckeye Pipe Line Co. | 200,000 | $50 | $1 | 12-15-39 | 2.00 | 2.36 | 4.02 | 39 | 22½ | 51½ | 36 |
| 130 | 110 | .. | .. | .. | Chesebrough Mfg. Co. | 120,000 | $25 | $1.50Q† | 9-25-39 | 6.50 | 5.32 | 6.73 | 128 | 97 | 112 | 95½ |
| 9¼ | 4½ | 6 | 5½ | 5⅝ | Cities Service (new) | 3,704,067 | $10 | .... | 6-1-32 | .... | .23 | 1.02 | 11 | 5⅛ | 5⅝ | 1½ |
| 2¼ | ½ | 1⅞ | 1⅝ | 1¾ | Cosden Petroleum | 462,551 | $1 | .... | .. | .... | .... | .19 | 2⅜ | ⅞ | 5½ | 1½ |
| 28 | 16¾ | 24½ | 24 | 24 | Creole Petroleum | 6,975,383 | $5 | 50cSA† | 12-15-39 | 1.00 | 1.64 | 1.61 | 27½ | 17½ | 38⅝ | 20¼ |
| 7⅛ | 3⅝ | 4¾ | 4½ | 4¾ | Darby Petroleum | 351,390 | $5 | 25cSA | 1-15-39 | .50 | .... | 1.36 | 10¼ | 5½ | 18⅝ | 6½ |
| 2⅝ | 1½ | 2⅜ | 2 | 2⅜ | Derby Oil & Refining | 263,162 | N.P. | .... | ..... | .... | —.91 | 1.34 | 3½ | 1½ | 8⅜ | 2¼ |
| 22 | 15⅛ | 22 | 22 | 22 | Eureka Pipe Line | 50,000 | $50 | 50c | 11-1-39 | 3.00 | —.37 | —.12 | 31 | 16 | 47½ | 24½ |
| 45⅛ | 29¼ | 42¼ | 40 | 40⅛ | Gulf Oil Corp. | 9,076,202 | $25 | 25cQ | 10-1-39 | 1.00 | 1.43 | 3.51 | 46⅞ | 33 | 63½ | 33 |
| 71 | 52½ | 67¾ | 64¾ | 65⅛ | Humble Oil & Refining | 8,987,840 | N.P. | 62½c | 10-2-39 | 3.00 | 3.98 | 5.22 | 72⅝ | 56 | 87 | 54⅞ |
| 17 | 11⅜ | 15⅛ | 14⅝ | 14⅜ | Imperial Oil of Canada | 26,965,078 | N.P. | 62½cSA†‡ | 6-1-39 | 1.25 | .96 | .98 | 19½ | 14⅛ | 24¼ | 14½ |
| 7¼ | 5⅝ | 5⅞ | 5¾ | 5⅞ | Indiana Pipe Line | 300,000 | $10 | 20c | 11-15-39 | .50 | .47 | 1.03 | 9⅜ | 6 | 15 | 5⅞ |
| 27½ | 17½ | 22⅝ | 21½ | 21½ | International Petroleum | 14,324,088 | N.P. | 1.00†‡ | 6-1-39 | 2.50 | 1.98 | .... | 31¼ | 21 | 39½ | 23½ |
| 3¾ | 2⅛ | 2½ | 2½ | 2½ | Kirby Petroleum Co. | 500,000 | $1 | 10c | 4-15-38 | .10 | .14 | .17 | 5 | 2⅛ | 8¾ | 2⅝ |
| 10¼ | 7⅛ | 10¼ | 10 | 10¼ | Lone Star Gas | 5,553,747 | N.P. | 20c | 8-21-39 | .60 | .88 | 1.14 | 10⅝ | 6⅝ | 14¼ | 5¼ |
| 7¾ | 4 | 5¼ | 4⅞ | 4⅞ | Louisiana Land & Exp. | 2,977,449 | $1 | 10cQ | 9-15-39 | .45 | .45 | .58 | 9⅜ | 6½ | 15¼ | 6⅜ |
| 17 | 14½ | .. | .. | .. | Margay Oil Corp. | 149,943 | N.P. | 25cQ | 10-10-39 | 1.00 | 2.28 | 3.26 | 24 | 16 | 33½ | 17 |
| 8¾ | 6⅝ | 7¾ | 7½ | 7½ | Midwest Oil Co. | 998,474 | $10 | 45c | 6-15-39 | 1.00 | .93 | 1.14 | 9¾ | 6⅝ | 14⅝ | 6¼ |
| 5⅞ | 4⅞ | 5⅞ | 5½ | 5½ | Mountain Producers | 1,593,584 | $10 | 30cSA | 6-15-39 | .60 | .62 | .76 | 5¾ | 4½ | 7⅞ | 4⅛ |
| 14 | 11¼ | 13⅛ | 12½ | 12¾ | National Fuel Gas | 3,810,183 | N.P. | 25cQ | 10-16-39 | 1.00 | .84 | .96 | 14⅝ | 11½ | 19½ | 12 |
| 9¼ | 7¼ | 9 | 9 | 9 | National Transit | 509,000 | $12.50 | 35c | 6-15-39 | .75 | .88 | 1.19 | 9¼ | 6½ | 12½ | 7¼ |
| 1¾ | 1½ | 1½ | 1½ | 1½ | New Mexico and Arizona | 1,000,000 | $1 | 1c | 12-1-37 | .... | .02 | .02 | 2⅝ | 1½ | 5 | 1⅛ |
| 4⅞ | 4 | .. | .. | .. | New York Transit | 100,000 | $5 | 25c | 10-14-39 | .25 | .16 | .49 | 4½ | 3½ | 5⅝ | 3⅞ |
| 6 | 4½ | .. | .. | .. | Northern Pipe Line | 120,000 | $10 | 15c | 12-1-39 | .35 | .24 | .78 | 6 | 4 | 12¾ | 5¾ |
| 7⅝ | 4 | 5¼ | 5 | 5 | Pantepec Oil | 2,857,000 | $1 | .... | ..... | .... | .... | .... | 7¾ | 3½ | 9⅝ | 2¾ |
| 5 | 1¼ | 3½ | 3¼ | 3¼ | Root Petroleum Co. | 336,045 | $1 | 25c | 2-1-37 | .... | .17 | —.17 | 4½ | 1⅝ | 12¾ | 2 |
| 3 | 1⅞ | 2½ | 2¼ | 2½ | Ryan Consolidated | 298,931 | N.P. | .... | ..... | .... | .29 | .46 | 4 | 2⅛ | 6½ | 2¼ |
| 4⅞ | 3½ | 4¾ | 4¾ | 4¾ | Southern Pipe Line | 100,000 | $10 | 15cSA | 9-1-39 | .30 | —.27 | .85 | 5⅜ | 3¼ | 7¼ | 3⅞ |
| 39½ | 26¾ | 36⅞ | 36¼ | 36¼ | South Penn Oil | 1,000,000 | $25 | 37½cQ | 9-29-39 | 1.75 | 1.44 | 4.64 | 39 | 28¾ | 56 | 35 |
| 23 | 18 | .. | .. | .. | Southwest Penna. Pipe Lines | 35,000 | $50 | 50cQ | 10-2-39 | 2.00 | —.41 | .95 | 22¼ | 16½ | 42 | 20 |
| 19⅝ | 17¼ | 19⅝ | 19 | 19 | Standard Oil of Kentucky | 2,604,790 | $10 | 25c | 9-15-39 | 1.25 | 1.45 | 1.60 | 18¾ | 15 | 21⅛ | 14¾ |
| 26⅞ | 17 | 26⅞ | 26 | 26 | Standard Oil of Ohio | 753,740 | $25 | 75c† | 12-15-39 | 1.00 | 1.81 | 3.67 | 22¾ | 16¼ | 45 | 16 |
| 2¾ | 1¾ | 2¼ | 1⅞ | 2 | Sunray Oil | 2,007,076 | $1 | 5c | 4-27-39 | .05 | .23 | .42 | 3¼ | 2 | 4⅞ | 2 |
| 4 | 2⅝ | 3 | 2⅞ | 3 | Texon Oil & Land | 936,024 | $2 | 10c | 6-30-39 | .80 | .56 | .51 | 5¼ | 3½ | 7⅝ | 2 |
| 6 | 2½ | 3¼ | 3 | 3 | Transwestern Oil Co. | 750,000 | $10 | .... | ..... | .... | —.12 | .48 | 7⅝ | 4¼ | 13⅞ | 4⅝ |
| 3⅜ | 1⅝ | 2⅝ | 2¼ | 2¼ | United Gas Corp. | 7,818,959 | $1 | .... | ..... | .... | —.51 | .25 | 5¼ | 2⅝ | 13⅞ | 3 |

†Includes extras. ‡Payable in Canadian funds. —Deficit.

# September Domestic Demand For Gasoline Up 7 Per Cent

IN September the production of crude oil completely recovered from the 15-day shutdown, the daily average rising to 3,605,600 bbl., or virtually 1,000,000 bbl. above the average in August.

Illinois continued to hold the spotlight, its daily average rising to a new record of 348,100 bbl., or about 30,000 bbl. above August. However, this record may hold for some time as preliminary figures indicate no further gain in October. California's output gained slightly but Michigan fell back from its record of August. Of the six shutdown states, only two, Arkansas and Texas, increased their output over the average in July.

In spite of the gain in output, nearly 4,000,000 bbl. of crude were withdrawn from stocks. Factors of importance in this decline in stocks were a gain of 45,000 bbl. in daily average crude runs to stills, and a gain of about 1,000,000 bbl. in exports.

The yields of gasoline and distillates were unchanged from August at 45.1 and 12.3 per cent, respectively. The yield of residual fuel oil increased 1.4 per cent, reflecting the strengthened demand for the product.

The demand for motor fuel continued to exceed average expectations both in the domestic markets and in exports. The domestic demand in September was 49,347,000 bbl., or 7 per cent above the demand in September 1938. Considering shipping conditions, exports of motor fuel held up well, being 4,232,000 bbl., or well ahead of last September.

The gain in distillate demand over a year ago was moderate but the domestic demand for residual fuel oil was up 15 per cent. The domestic and export demands for lubricating oils both increased over a year ago and exports of paraffin wax, used extensively in munitions, reached 30,193,000 lb., the highest since December 1931.

According to the Bureau of Labor Statistics, the price index for petroleum products in September 1939 was 53.3, compared with 51.7 in August and 56.4 in September 1938. This was the first gain in the index since May.

The crude-oil capacity represented by the data in this report was 4,154,000 bbl., hence the operating ratio was 85 per cent, compared with 84 per cent in August and 79 per cent in September 1938.

### *United States Supply and Demand—Crude Oil (Bbl.)*

| | September 1939 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9 MONTHS— | TOTAL SUPPLY | TOTAL DEMAND | EXCESS DEMAND | EXCESS PCT. | DOMESTIC PRODUCTION | IMPORTS | INDICATED DOMESTIC DEMAND‡ | EXPORTS | STOCKS REFINABLE CRUDE SEPT. 30 |
| 1939 | 947,897,000 | 989,284,000 | 41,387,000 | 4.2 | 923,361,000 | 24,536,000 | 934,137,000 | 55,147,000 | ‖234,555,000 |
| Daily average | 3,472,000 | 3,624,000 | ..... | .... | 3,382,000 | 90,000 | 3,422,000 | 202,000 | ..... |
| 1938 | 930,133,000 | 950,180,000 | 20,047,000 | 2.1 | 911,633,000 | 18,500,000 | 890,191,000 | 59,989,000 | 282,756,000 |
| Daily average | 3,407,000 | 3,481,000 | ..... | .... | 3,339,000 | 68,000 | 3,261,000 | 220,000 | ..... |
| Increase, 1939 | 17,764,000 | 39,104,000 | ..... | .... | 11,728,000 | 6,036,000 | 43,946,000 | †4,842,000 | †48,201,000 |
| | 1.8% | 4.1% | ..... | .... | 1.2% | 32.1% | 4.9% | †8.1% | †17.0% |

### *Supply and Demand—Refinery Products Motor Fuel (Bbl.)*

| 9 MONTHS— | TOTAL SUPPLY | TOTAL DEMAND | EXCESS DEMAND | EXCESS PCT. | DOMESTIC PRODUCTION | IMPORTS | DOMESTIC DEMAND‡ | EXPORTS | STOCKS SEPT. 30§ |
|---|---|---|---|---|---|---|---|---|---|
| 1939 | *447,931,000 | 447,321,000 | *610,000 | *0.1 | 447,925,000 | 6,000 | 411,901,000 | 35,420,000 | 76,883,000 |
| Daily average | 1,641,000 | 1,639,000 | ..... | .... | 1,641,000 | 22 | 1,509,000 | 130,000 | ..... |
| 1938 | 422,946,000 | 426,274,000 | 3,328,000 | 0.8 | 422,867,000 | 79,000 | 389,812,000 | 36,462,000 | 77,245,000 |
| Daily average | 1,549,000 | 1,561,000 | ..... | .... | 1,549,000 | 290 | 1,428,000 | 134,000 | ..... |
| Increase, 1939 | 24,985,000 | 21,047,000 | ..... | .... | 25,058,000 | †73,000 | 22,089,000 | †1,042,000 | †362,000 |
| | 5.9% | 5.0% | ..... | .... | 5.9% | †92.4% | 5.6% | †2.8% | †0.4% |
| ***Kerosene*** | | | | | | | | | |
| 1939 | 50,916,000 | 48,763,000 | *2,153,000 | *4.4 | 50,916,000 | ..... | 42,846,000 | 5,917,000 | 9,952,000 |
| 1938 | 48,102,000 | 44,688,000 | *3,414,000 | *7.6 | 48,102,000 | ..... | 38,994,000 | 5,694,000 | 10,497,000 |
| Increase, 1939 | 2,814,000 | 4,075,000 | ..... | .... | 2,814,000 | ..... | 3,852,000 | 223,000 | †545,000 |
| | 5.9% | 9.1% | ..... | .... | 5.9% | ..... | 9.7% | 3.9% | †5.2% |
| ***Gas Oil and Residual Fuel Oil*** ¶ | | | | | | | | | |
| 1939 | 357,448,000 | 363,278,000 | 5,830,000 | 1.6 | 344,733,000 | 12,715,000 | 324,369,000 | 38,909,000 | 138,201,000 |
| 1938 | 346,977,000 | 325,583,000 | *21,394,000 | *6.5 | 330,927,000 | 16,050,000 | 288,929,000 | 36,654,000 | 133,691,000 |
| Increase, 1939 | 10,471,000 | 37,695,000 | ..... | .... | 13,806,000 | †3,335,000 | 35,440,000 | 2,255,000 | 4,510,000 |
| | 3.0% | 11.5% | ..... | .... | 4.1% | †20.7% | 12.2% | 6.1% | 3.3% |
| ***Gas Oil and Distillate Fuels*** | | | | | | | | | |
| 1939 | 118,634,000 | 117,008,000 | *1,626,000 | *1.4 | 118,463,000 | 171,000 | 91,857,000 | 25,151,000 | 38,138,000 |
| 1938 | 111,288,000 | 103,382,000 | *7,906,000 | *7.6 | 111,288,000 | ..... | 79,998,000 | 23,384,000 | 30,860,000 |
| Increase, 1939 | 7,346,000 | 13,626,000 | ..... | .... | 7,175,000 | ..... | 11,859,000 | 1,767,000 | 7,278,000 |
| | 6.6% | 13.2% | ..... | .... | 6.4% | ..... | 14.8% | 7.6% | 23.6% |
| ***Residual Fuel Oils*** | | | | | | | | | |
| 1939 | 238,814,000 | 246,270,000 | 7,456,000 | 3 0 | 226,270,000 | 12,544,000 | 232,512,000 | 13,758,000 | 100,063,000 |
| 1938 | 235,689,000 | 222,201,000 | *13,488,000 | *3.2 | 219,639,000 | 16,050,000 | 208,931,000 | 13,270,000 | 102,831,000 |
| Increase, 1939 | 3,125,000 | 24,069,000 | ..... | .... | 6,631,000 | †3,506,000 | 23,581,000 | 488,000 | †2,768,000 |
| | 1.3% | 10.8% | ..... | .... | 3.0% | †21.8% | 11.3% | 3.7% | †2.7% |
| ***Lubricating Oils*** | | | | | | | | | |
| 1939 | 24,706,000 | 25,701,000 | 995,000 | 3.8 | 24,706,000 | ..... | 17,205,000 | 8,496,000 | 6,704,000 |
| 1938 | 23,275,000 | 23,186,000 | *89,000 | *0.4 | 23,275,000 | ..... | 15,859,000 | 7,327,000 | 7,605,000 |
| Increase, 1939 | 1,431,000 | 2,515,000 | ..... | .... | 1,431,000 | ..... | 1,346,000 | 1,169,000 | †901,000 |
| | 6.1% | 10.8% | ..... | .... | 6.1% | ..... | 8.5% | 15.9% | †11.9% |
| ***Petroleum Wax (Lb.)*** | | | | | | | | | |
| 1939 | 347,796,000 | 387,552,000 | 39,756,000 | 10.3 | 322,560,000 | 25,236,000 | 201,073,000 | 186,479,000 | 89,584,000 |
| 1938 | 346,007,000 | 361,981,000 | 15,974,000 | 4.6 | 319,760,000 | 26,247,000 | 221,441,000 | 140,540,000 | 129,018,000 |
| Increase, 1939 | 1,789,000 | 25,571,000 | ..... | .... | 2,800,000 | †1,011,000 | †20,368,000 | 45,939,000 | †39,434,000 |
| | 0.5% | 7.1% | ..... | .... | 0.9% | †4.0% | †9.2% | 32.6% | †30.6% |

*Excess supply. †Decrease. ‡Crude oil only. §Includes finished and unfinished refinery gasoline and natural gasolines. ¶Gas oil and fuel oil equals gas oil and distillate fuels plus residual fuel oils. Note: Total supply equals domestic production plus imports. Total demand equals domestic demand plus exports. Data on demand for refined products are based on refinery shipments. ‖Does not include 14,085,000 bbl. of heavy oils in California. Comparable figure for Sept. 30, 1938, 17,535,000 bbl.

### *Crude Oil Run to Stills and Total All Oils (Bbl.)*

| 9 MONTHS— | TOTAL IMPORTS§ | TOTAL EXPORTS§ | TOTAL CRUDE TO STILLS | PER CENT YIELD GASOLINE‡ | NATURAL GASOLINE PRODUCTION | TOTAL SUPPLY ALL OILS* | TOTAL DEMAND ALL OILS* | STOCKS ALL OILS SEPT. 30* |
|---|---|---|---|---|---|---|---|---|
| 1939 | 44,545,000 | 145,878,000 | 916,109,000 | 44.7 | 36,557,000 | 1,006,102,000 | 899,267,000 | 515,427,000 |
| Daily average | 163,000 | 535,000 | 3,356,000 | ... | 134,000 | 3,685,000 | 3,294,000 | ..... |
| 1938 | 39,415,000 | 147,380,000 | 868,955,000 | 44.1 | 38,125,000 | 990,380,000 | 831,410,000 | 576,587,000 |
| Daily average | 144,000 | 540,000 | 3,193,000 | ... | 140,000 | 3,628,000 | 3,045,000 | ..... |
| Increase, 1939 | 5,130,000 | †1,502,000 | 47,154,000 | ... | †1,568,000 | 15,722,000 | 67,857,000 | †61,160,000 |
| | 13.0% | †1.0% | 5.4% | ... | †4.1% | 1.5% | 8.1% | †10.6% |

*Total all oils includes crude and refined products, natural gasoline and benzol. Stocks Sept. 30, 1939, represented 135 days' supply which compared to 161 days on the same date in 1938. †Decrease. ‡Does not include natural gasoline blended at refineries. §Includes crude oil and refinery products. In case of imports includes receipts in bond and for domestic use. All data based on Bureau of Mines reports.

# New or Improved Equipment

## Sight Glasses for Pipe Lines Indicate Duration of Flow

Many applications for a visible-flow fitting are found in power plants and process industries to provide continuous checks on operation of equipment and observe

the fluid in flow under pressures up to 125 lb. per sq. in.

Developed by Cochrane Corp., Seventeenth Street and Allegheny Avenue, Philadelphia, Pa., to facilitate the observation of the duration of the blowoff from hot-process softener sedimentation tanks, the closed fitting equipped with sight glasses is advantageous in that it permits discharge of the sludge to the sewer under pressure as well as permitting a smaller line than would be necessary with gravity flow from an open funnel as is customary.

The Cochrane sight glass has been designed in six sizes for 2½, 3, 4, 5, 6, and 8-in. lines for any purpose where visual inspection of fluid flow is desired. The body is of cast iron and the window frame is of steel. Windows are made of Pyrex glass. The sight-glass fitting is flanged for installation in the line, and all sizes measure 13¼ in. between finished surfaces. Windows are 4¼ in. in diameter for all sizes.

## Dia-Loy Sucker-Rod Couplings Lighten Abrasion Problems

The Dia-Loy sucker-rod coupling, manufactured by Dia-Loy Co., 101 North Alameda Avenue, Burbank, Calif., is designed to solve abrasion and corrosion problems met in sandy, crooked, and sour pumping wells. It is to be applied on a string of rods in the same manner as the conventional rod couplings now commonly used.

The Dia-Loy coupling is of standard A.P.I. construction. There are two types of couplings. Type A has a body made of heat-treated steel with tensile strength sufficient to carry the heaviest well loads. Type B has a body of nonferrous alloy of high tensile strength and toughness, also capable of carrying heavy loads. To the body of each of these types a hardened ring of special alloy is combined under a process for which a patent has been applied. This ring is of a large cross section in thickness and is of uniform hardness throughout. It will retain its physical properties under heat ranges up to 1,800°.

Owing to the design and construction employing the hardened ring of special alloy, the manufacturers say, this rod coupling will not score, wear or siege itself or the tubing under the severest abrasion. These couplings have been placed in continuous operation in abrasive wells over a period of a year. While other couplings had to be replaced because of excessive wear, Dia-Loy couplings in the same strings are said to have shown no appreciable signs of wear.

Dia-Loy's Mid-Continent representative is Charles A. Russell, Box 1044, Houston, Tex.

## New Alligator V-Belt Fastener Widens Field of V-Belt Drive

The V-belt fastener announced 2 years ago under the tradename of Alligator by Flexible Steel Lacing Co., 4607 Lexington Street, Chicago, and widely used in the railway field, has been brought out for B, C, and D section V-belts. The use of the fastener, however, is limited to the crosswoven fabric core V-belts now being built by some manufacturers and should not be applied to cord belts.

The company states that the use of V-belts in the past has been limited to services where endless belts could be used. It is said, therefore, that the new Alligator V-belt fasteners broaden the field of application for V-belt drives. With these fasteners it will be possible to install and maintain matched lengths of V-belts on multiple drives without tearing down installations. It also will be possible to make up a wide variety of multiple V-belt drives right from stock coils of belting.

*Before application*

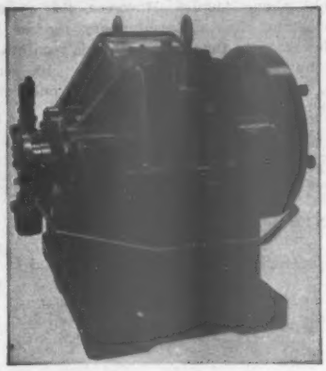
*Ready for fastening*

The illustrations show the simplicity of this V-belt fastener and the ease with which it is applied. The fastener consists of two die-formed steel end plates, two bushings, two two-piece rocker pins, and special nails.

Friction wear is reduced as there is no sliding movement of either end plates, bushings or links. As the fastener passes around the sheave the only internal movement is at the knife edge of the rocker pins.

## Westinghouse Announces New Line of Speed Increasers

A new line of speed increasers for operating centrifugal pumps, high-speed blowers, and compressors, and for pipe-line service has been announced by Westinghouse Electric & Manufacturing Co. Standard gear ratios vary from 2 to 1 to 12 to 1, and these new units are available in ratings of 1 hp. per 1,000 r.p.m. of the high-speed shaft to more than 1,800 hp. per 1,000 r.p.m.



Speed increasers can be supplied for either right or left-hand assembly. Sleeve bearings have been designed to provide low unit pressures and assure permanent alignment with minimum friction loss. Lubrication is accomplished by a self-contained circulating oil system, including a circulating pump, an oil cooler, strainer, relief valve, and sight flow indicator. Gears are spray-lubricated at the line of contact. All bearings are under pressure lubrication. Frames are split horizontally to permit easy access to all internal parts, and each unit has an easily removable inspection plate. Average efficiency of these units is said to be better than 96 per cent.

## New Tanker for Atlantic Refining

Atlantic Refining Co. has awarded to Sun Shipbuilding & Dry Dock Co., Chester, Pa., a contract for the construction of a 19,405-ton, all-welded turboelectric tanker to be delivered late in 1940. The tanker will be the fourth of the same general type of construction built for Atlantic at the Sun yards since 1936. The vessels in this group are the world's largest welded ships. The newest addition will have an overall length of 543 ft. 10 in. and a beam of 70 ft. Capacity will be the equivalent of 156,000 bbl. The tanker will be placed in service between Philadelphia and Texas Gulf ports.

## GREEN HEAD SALES AND SERVICE FACILITIES EXPANDED

Expansion of its service facilities with the completion of modern and larger sales and stock rooms is announced by Paul Snetcher, of Green Head Bit & Supply Co., Oklahoma City, Okla. Besides two new and improved designs in its drilling bits, Green Head has added to its list of distributed products.

The men in front of Green Head's headquarters are Paul Snetcher and Fred Martin.

## Stress-Relieving Furnace Now in Operation at Wyatt Plant

Wyatt Metal & Boiler Works has completed and placed in operation in its Houston, Tex., plant a new stress-relieving furnace, which handles vessels 15 ft.

6 in. in diameter. This furnace, of the very latest design, places Wyatt in a position to fabricate vessels in accordance with Paragraph U-68 (Class 1) requirements of the A.S.M.E. code and A.P.I.-A.S.M.E. code to sizes limited only by railroad clearance. The furnace car has a capacity of 300 tons, which is far in excess of actual load requirements.

The new stress-relieving furnace employs the most

modern control equipment, permitting permanent records of the stress-relieving operation of any vessel. Micromax strip-chart type recorded controllers, with a range of 200 to 2,000° F., are hooked up with Chromel-Alumel thermocouples mounted in drawn-chrome iron tubes.

To facilitate the maintenance of uniform temperatures throughout the furnace chamber, horizontally as well as vertically, the furnace is equipped with two-stage, high-pressure inspiriting-type burners, arranged in two rows on each side, top and bottom, and spaced approximately on 5-ft. centers.

This new furnace enables Wyatt to take care of any size vessel and equipment that may be built in a steel-plate fabricating shop. In conjunction with the stress-relieving furnace, the company's 220 OX industrial radiographic unit provides facilities for the manufacturing of equipment in strict accordance with the A.P.I.-A.S.M.E. code.

## Here and There With Men Who Manufacture Equipment

Continental Supply Co. has opened a new store at Golden Meadow, La., in charge of Raleigh Hortenstine, Jr., formerly salesman in Continental's Houston office.

Len Moon, formerly manager of the Cavins Co. branch at Taft, Calif., has been transferred to the Mid-Continent and Gulf Coast, where he will assist branch managers. He expects to apportion his time equally among the offices in Houston, Corpus Christi, and Odessa, Tex., and Ada, Okla.

Chain Belt Co., Milwaukee, Wis., has made Edward J. Greene an assistant treasurer. He formerly was assistant treasurer and purchasing agent of Baldwin-Duckworth Chain Corp., Springfield, Mass., recently merged with Chain Belt.

George Koons, foreign representative for Buda Engine Co., Harvey, Ill., is on a business trip through Mid-Continent oil fields, after spending 2 years covering important oil fields in Europe. At the completion of the trip he will sail for South American oil fields.

## International Trucks Will Get Punishment on Test Grounds

Construction of proving grounds for the testing of motor trucks produced by International Harvester Co. on a tract of land southeast of Fort Wayne, Ind., has been announced by C. M. Harrison, superintendent of the company's Fort Wayne works.

An oval-shaped concrete pavement will correspond to highway pavements of the United States. A stretch of highway paved with Belgian road blocks will test trucks on rough going similar to that often encountered in large cities and especially in the older European cities. Trucks will be driven through water, sand, and mud at various speeds in order to determine the effect upon vital mechanical parts. A gravel road will be used to test trucks on a type of surface common in rural highways. Here the effect of dust on vital parts of the truck will be noted. A "twist course" will provide punishment for the truck's chassis.

## Patton Is Made Sales Manager

C. S. Patton has been appointed sales manager of the Alco Products Division of American Locomotive Co., in charge of the sale of heat exchangers, condensers, feedwater heaters, evaporators, tubular equipment, code pressure vessels, fabricated-plate work, water pipe and allied lines.

Mr. Patton graduated from Cornell with the degree of mechanical engineer in 1918. For the next 8 years he was connected with the shipbuilding industry in various capacities. In 1926 he became New York manager for Biggs Boiler Works Co., Akron, Ohio. In 1929 he took charge of the sales of fabricated plate work for Heat Transfer Products Co., which position he held after the Heat Transfer Products Co. was acquired by American Locomotive Co. and later expanded into Alco Products, Inc. Later, he was made manager of equipment sales for Alco Products Division, which position he held up to his latest advancement.

## Taylor Now Chief Engineer

Gulberson Corp., Dallas, Tex., has appointed R. G. Taylor, Jr., chief engineer to succeed Albert Pranger who has taken up special field research work in finding and developing new products for the company.

Mr. Taylor began his technical career as a mechanic for Douglas Aircraft Co., at Santa Monica, Calif., in 1929. Two years later he took up the study of mechanical engineering at the University of Southern California. After completing his studies he served successively with Hogan Petroleum Co., at Bakersfield, Calif., as roughneck; Bell & Loffland, drilling contractors, and W. R. Gulberson Co., of Los Angeles, as field sales representative and engineer. Last January he was transferred to the Gulberson headquarters in Dallas, where he served as gas-lift engineer in connection with the sales of Gulberson gas-lift flow valves and related equipment.

## Giant Timken Bearings to Help in Fighting Antarctic Snows

Constructed to conquer snow-clad wastes of the Antarctic, the Snow Cruiser, designed and built under the sponsorship of the Research Foundation of Armour In-

stitute of Technology, is rolling towards Boston for shipment to Little America.

As this 38-ton machine wends its ponderous way through cities and villages, thousands will wonder what kind of bearings are required to support the four gigantic wheels on which the weird-looking monster travels. They are Timken tapered roller bearings, the same as the bearings used in a majority of modern American streamlined trains and locomotives.

Each of the huge wheels is 10 ft. in diameter and weighs 3 tons completely assembled. Bearings for wheels of such size and weight constituted a major problem. This was solved by Timken Roller Bearing Co., which designed and made special tapered roller bearings for the purpose.

These bearings, the largest ever made for installation in wheels, have an inside diameter of 24 inches and an outside diameter of 32 inches. They have a normal carrying capacity of 127,000 lb., although the actual maximum load to be carried will not exceed 19,000 lb. per wheel.

Going as it is deep into the Antarctic wilderness, where no facilities exist for major repairs or replacements, absolute dependability in every detail of the cruiser's construction is vitally important. No spare bearings are being carried.

## Farmer Goes to Dallas Office

Installations of the new Otis removable bottom-hole regulator in South, East and West Texas, Gulf Coast, Louisiana and New Mexico fields since August 1 have made it necessary for Otis Pressure Control, Inc., to add to the engineering department of its Dallas, Tex., office. John O. Farmer, an engineer who has been connected with various division offices of Otis Pressure since 1935, has been transferred to headquarters to assume new duties, chiefly in relation to the regulator.

Mr. Farmer, who graduated from the Missouri School of Mines in 1933, was with Carter Oil Co. in Oklahoma as a junior engineer until leaving to join the Oklahoma City division of Otis Pressure. There he devoted most of his time to pressure-control drilling in the Mansion area, where 95 per cent of the wells were completed by Otis Pressure drilling methods.

It was Mr. Farmer who installed an Otis removable bottom-hole choke in every well in the Peasel field at Wellington, Kans. Gas oil-ratios were reduced, in some cases, from 9,000 cu. ft. per bbl. to 3,000.

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## Leases and Drilling Blocks

LEASES—East Texas, La., South Ark. 20 acres up, dollar acre up.—Owners—Address Attorney, Box 1122, Little Rock, Ark.

**BROKERS and SALESMEN**
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A complete SERVICE EXPERTS in every department of the Oil Business at your SERVICE a REAL SET-UP. The best opportunity ever offered you. Leases in large or small lots at
WHOLESALE PRICES
Write today and get started right.
**OIL BROKERS EXCHANGE**
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SACRIFICE 40-acre Oil Lease, Chaves County, for only $10.00, full price. Guarantee title. P. O. Box 191, Clovis, N. Mex.

NEW MEXICO WEEKLY OIL SCOUT REPORT. — Send for sample copy. Roy G. Barton, Box 968, Hobbs, N. M.

WANT CAPITAL to invest in perpetual mineral rights in North Permian Basin in Texas and New Mexico in major company blocks on geophysical highs. Rapid development under way now. Will take interest after all monies have been repaid. Address Box J-990, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE Oil and gas leases and small production located in Kentucky shallow field, and leases located in Clay County, Tenn. Have for sale two tracts of proven Fluorspar and Zinc deposits; reports furnished on request. W. P. Harley, Bowling Green, Kentucky.

MAKE money with wildcat leases in Southwest Texas. 50c per acre up. Address P. O. Box #410, Austin, Texas.

MISSISSIPPI THE NEW OIL STATE Leases, royalties and drilling blocks apply J. P. Fraim, Edwards Hotel, Jackson, Miss.

FOR Concordia Parish, La. leases, blocks 320 to 15,000 acres, write C. W. Deming, Registered Dealer, Waycross, Georgia.

NEW MEXICO
STATE OIL AND GAS LEASES
Buy on known structures where major companies own leases. 50c per acre. 5c rentals. Write for information.
HARRY S. WRIGHT, STATE LESSEE
Wright Building
FARMINGTON, NEW MEXICO

WILL farm out drilling block North Texas. Excellent possibilities. Big Production. Exploration, Inc., 505 Pet. Bldg., Ft. Worth, Texas.

WOULD like to contact responsible Independent Driller to drill on 50-50 basis. Proven shallow fields in north La. Also have several thousand acres S.W. La. good possibilities, to lease. Wonderful opportunity for good production. Unless you mean business, please do not reply. Address Box K-361, The Oil and Gas Journal, Tulsa, Oklahoma.

## Leases and Drilling Blocks

DRILLING DEALS WANTED
Will drill for cash and interest.
CLAUDE L. JORDAN, Bristow, Oklahoma.

KENTUCKY
I own in fee the oil and gas rights under 20,000 acres located in McCreary County on a structure which I will lease for development on a reasonable basis
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Lawrenceburg, Indiana.

FOR LEASE—100 acres producing oil land. Write or contact Joshua Bland, 1012 Cherry St., Orange, Texas.

FOR SALE—Leases, proven shallow depth gas field, Johnson County, Kansas. 40 acres and up. $5.00 an acre and down. Box K-364, The Oil and Gas Journal, Tulsa, Oklahoma.

YAZOO, MISSISSIPPI
DIXIE ROYALTY COMPANY
Can deliver choice leases and Royalty in direct Northeast trend. Commission to Brokers.

FOR LEASE for Oil. 140 A. in Brewster County, Texas, about 60 miles Southeast Alpine, Texas. Herman Johnson, 331½ Chevenne Blvd., Colorado Springs, Colo.

## Legal Blanks

SINCE 1908 Burkhart's legal forms—servicing Mid-Cont. oil fields, including Ill., La., Mo., Ind. & Ky. Free catalog & samples. Burkhart Ptg. & Sta. Co., 115 So. Cinn., Tulsa, Oklahoma.

## Mailing Lists

ROYALTY Lists. Oil Investor Lists. Stockholders Lists. By states. Oil Industry Mailing List Co., Tulsa Loan Bldg., Tulsa, Oklahoma.

## Help Wanted

SALESMAN in each settled production area. Sideline. Good thing. Eclipse Chemical Co., Box 2603, Tulsa, Oklahoma.

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For small company producing oil and natural gas. Knowledge of repressuring with natural gas essential. Apply stating experience, references and salary expected to Box K-360, The Oil and Gas Journal, Tulsa, Oklahoma.

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REFINERY ENGINEER—12 years' experience in oil refinery drafting, estimating, cost control and field work. Last 8 years with one major company holding responsible position. College graduate. Address Box K-310, The Oil and Gas Journal. Tulsa, Oklahoma.

OIL Accountant. Experience—development—production—refining. Excellent references. Address Box K-334, The Oil and Gas Journal, Tulsa, Oklahoma.

EXECUTIVE. Oil Well Supply, Steel fabricating, and oil experience. Broad, practical knowledge of financial, sales, production, legal and administration problems. P. O. Box 134, South Pasadena, Calif.

CHEMICAL Engineer with sales and executive ability, 31 years old, married, good appearance, ten years' experience in industry, detailed knowledge of latest catalytic processes and economical USP white oil manufacture seeks permanent position with progressive company. Also successful safety engineering experience. Excellent references. Address reply to Box K-363, The Oil and Gas Journal, Tulsa, Oklahoma.

EXPERIENCED Cable Tool and Production Superintendent. Now employed, wishes to make change. Address Box K-362, The Oil and Gas Journal, Tulsa, Oklahoma.

BUSINESS MANAGER for independent oil company or Drilling Contractor. Considerable experience in leasing, acquiring contracts, financing, and business administration. P. O. Box 66, Sta. A, Los Angeles, California.

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Put your project before 260 Key-Men. Cost trifling. Details free. AMSTER LEONARD, Fox Theater Building, Detroit, Michigan.

CORPORATE ORGANIZING and FINANCING—RE-ORGANIZATIONS
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KNOWN FROM COAST TO COAST
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**WE GUARANTEE**

these items to be outstanding values, as our prices are based on loans made to Jewelers and Indviduals, which have been forfeited by them, and are offered to you at a fraction of their original cost.

**9.72 CT. DIAMOND,** Round Blue White, American Cut, brilliant, set in a man's heavy white gold ring. $3250 value.
Sale Price ..... **$1295**

**8 CT. EMERALD CUT DIAMOND,** Canary Color, Perfect and flawless, unusual brilliancy, set in lady's all platinum ring with 2 baguette diamonds. $5000 value.
Sale Price ..... **$2000**

**5.56 CT. DIAMOND,** Round, Blue White, Finest American Cut, exceptionally brilliant, set in a man's all platinum hand made ring with 4 fancy shaped diamonds. $2000 value.
Sale Price ..... **$745**

**3.25 CT. DIAMOND,** Round, White, absolutely perfect and flawless, unusually brilliant, set in lady's all platinum ring with 14 diamonds. $1300 value.
Sale Price ..... **$550**

**2.05 CT. EMERALD CUT DIAMOND,** Blue White, unusually brilliant, set in man's hand-made all platinum ring with 6 extra large Blue White square cut diamonds. $1250 value.
Sale Price ..... **$525**

**DIAMOND BRACELET,** All platinum, set with 681 Blue White diamonds; 108 square cut, 84 baguette and 3 large Emerald Cut diamonds; total weight of diamonds 79 Cts. of the finest Blue White perfect matched quality. A REAL MASTERPIECE AND OUTSTANDING BUY! $25,000 value.
Sale Price ..... **$9500**

**"SEEING IS BELIEVING"**

We will send any article to your bank or Railway Express Agency, subject to your inspection, without cost or obligation, or direct to you upon references.

We will submit any article for appraisal before purchase; You select the appraiser.

**MEMBER OF CHICAGO ASSOCIATION OF COMMERCE**

**LEVINSON'S LOANS, INC.**
Est. 1888
**739 N. Clark St.**
**CHICAGO, ILL.**

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| 6 Lines | 2.10 | 3.60 | 5.10 | 6.60 |
| 7 Lines | $2.45 | $4.20 | $5.95 | $7.70 |
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Tulsa, Oklahoma

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**Foster-Wheeler Fractionating Column — 6'6"1Dx72' high. New Taylor Instruments throughout. Heat Exchangers, Hot Oil Pump Steam Engine Driven. Two Pipe Stills. 1 - 3" Tubes — 1 - 2½" Tubes.**

**WILL SELL ALL OR ANY PART**

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Freight Cars; any kind
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Freight Car Repair Parts
Perhaps *we* can supply your requirements, and *immediately?*
OTHER MACHINERY and EQUIPMENT, TOO!

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*"Anything containing IRON or STEEL"*

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COMPLETE PIPE YARD—WESTERN KANSAS. 2" 12½" 18" Bignall Keeler Pipe Machines, Westinghouse 350 Ampere Welder Truck trailer all Inventory at very low price. Address 553 North Fountain, Wichita, Kansas.

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1—20" x 10' Geared Head Motor Driven Lathe. 1—#14 Brown & Sharpe Plain Grinder. 1—#3 B&K Pipe & Bolt Machine; 1—1½" Landis Double Head Bolt Machine; 1—24" Wood Planer; 1—36" All Metal Band Saw, 1—52" Radial Drill. Nolan Sales Corporation, Tulsa, Oklahoma.

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Fresh Painted—Excellent condition.
We still have a few left.
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25 K.W. and 40 K.W. Gas Engines, 220 volts, D.C. Two 100 K.W. Gas Engine-Generator Sets, 220 volts, D.C. 7x8 Ingersoll-Rand ER-1 Air compressor. Six-inch Oster Pipe Threading Machine. Also large stock of lathes, pipe machines, milling machines, etc. Send for our list.

Terms to suit.
CINCINNATI MACHINERY & SUPPLY CO.
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**FOR SALE**

25,000 Ft. of 2" Pipe
10,000 Ft. of 2½"
35,000 Ft. of 3"
20,000 Ft. of 4"
10,000 Ft. of 6"
10,000 Ft. of 8", all threaded and collared line pipe strictly No. 1, located in Shreveport, Louisiana.
We also have 30,000 Ft. of 6" screw line Pipe in Oklahoma and 10,000 Ft. of 8" in Missouri.
Wire, Write or Phone for Prices.

**Louisiana Iron & Supply Co.**
**Shreveport, Louisiana**

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FOR SALE: One Caterpillar Diesel "75," 22" track, complete with LeTroneau cable controlled bulldozer, overhauled, $2,000.00 Pickwick Dam, Tenn. Also: One Allis Chalmers, Model L, 22" track, Baker hydraulic bulldozer, overhauled, $1750.00 Athens, Ala. Further particulars address O. C. Evans, Mount Sterling, Kentucky.

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**COMPRESSORS**

From 100# to 1000# discharge pressures in capacities from 100 cu. ft. to 3000 cu. ft. per minute either belted or direct connected gas, electric or Diesel types.

**ELECTRIC MOTORS**
From 5 to 250 HP

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From 25 to 500 HP

**PULLEYS**
Split steel, all sizes.

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FOR SALE—$80,000.00 Rotary Rig complete. 10-in. Emsco Unit, 125-350 Boilers, etc. Practically new. Bargain. Roberts Bros., Box 1322, Shreveport, La.

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Storage Tanks
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Main Plant and Office:
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Office at
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Arkansas City, Kansas

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6—4x8 National Triplex pumps. 4—10x18 Gaso Duplex power pumps, belt driven. 2—50-hp. Superior oil engines. 3—35-hp. Superior gas engines. 1—Galvanized iron steel frame building 28'x68'.
A. C. ASKEW
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ENGINE Bargains including 15 and 20 HP Fairbanks-Morse Oil Engines; 25 and 40 HP Tips Oil Engines; used and rebuilt. Write Tips Engine Works, Austin, Texas.

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LINE PIPE FOR SALE AT BARGAIN
15,000 feet plain end 13# 6⅝" OD USED LINE PIPE. Located near Kincaid, Kansas. If interested write Box 2451, Tulsa, Oklahoma, or phone 4-2121 Wichita, Kans.

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EQUIPMENT FOR SALE

2—Used Full Electric Diesel Powered Drilling Rigs—complete with Drill Pipe.
1—Used Electrical-Mechanical Diesel Powered Drilling Rig—Less Drill Pipe.
1—Complete Power End consisting of two 240 HP Fairbanks-Morse Engines with Sheldon-Burden Transmission for deep well drilling. Bargain.

All in first class condition. For inventory and Prices call or write
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## Equipment Wanted

WANTED TO BUY
GOOD USED SMALL PIPE ½ inch to 1½ inch inclusive black and galvanized; same size fittings and kind.
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P. O. Box 1442 Phone 606
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ANDREW J. BARRETT
The Philtower
Tulsa, Oklahoma.

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## Brokers—Salesmen

Sell in the most active area in the United States—The Permian Basin of West Texas and Southeastern New Mexico. From the standpoint of royalty investors this area has much to offer. Can supply you with choice non-producing royalties located on geophysical highs. Also drilling blocks, close in acreage to production, or wildcat leases. I maintain my own field men who cover this area for me. All offerings meet the requirements of the Security and Exchange Commission. Inquiries invited.

**B. D. BUCKLEY**
Paul Brown Bldg., St. Louis, Mo.

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PRODUCING royalty investments wanted. Sebago Oil Co., 719 McBirney Bldg., Tulsa, Oklahoma.

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WILL BUY Producing West Texas and New Mexico Royalties. Oscar L. Grimes, Tulsa Loan Building, Tulsa, Oklahoma.

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WE BUY AND SELL
PRODUCING AND
NON-PRODUCING ROYALTIES
We invite inquiries from dealers who are looking for royalties with exceptional value. (All offerings meet requirements of the Securities & Exchange Commission.)
CHESTER IMES
Tulsa Loan Bldg., Tulsa, Oklahoma

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## Incorporations

DELAWARE CHARTERS: Complete service $35. Submitted forms. Chas. G. Guyer, Inc., Wilmington, Delaware.

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CHARTERS — Delaware best, quickest, cheapest, more liberal. Free forms. Colonial Charter Co., Wilmington, Del.

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## Survey Service

REMEMBER EAST TEXAS
When all other methods fail, employ my divining or dowsing method. If oil exists this methods finds it. Faults, broken, treacherous areas accurately defined. Our Watson #2, first producer Wilmington, Calif. field, located by this method. More reliable than mechanical geophysics. Ask any unbiased oil authority. Many years' experience. A wise man investigates. George Miller, 1548 Post, Torrance, Calif.

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## For Sale—Maps

TEXAS and NEW MEXICO
UP-TO-DATE OIL DEVELOPMENT MAPS
Zingery Oil Map Co., Fort Worth, Tex.

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## Oil Industry Printing

OIL FIELD LEGAL BLANKS
Leases, assignments, releases, township plat books, well records, etc. Request on your letterhead gets free catalog. Olds Press, 215 East Third St., Tulsa, Okla.

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## Ranches—Farm Land

RANCHES and FARMS
Oklahoma, Texas, New Mexico; New low bargain prices—mountains or plains. Howard Ingram, Perrine Building, Oklahoma City, Oklahoma.

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# PETROLEUM-IZATION—1940

*(Continued from Page 115)*

ticularly as rumor has it that a catalytic-alkylation process is in the offing which produces excellent results from such a combined charge.

### Conclusion

In conclusion, it was the hope, in the preparation of this discussion, that if nothing else was accomplished one thing at least would make an impression. With these many and varied processing methods unfolding before our eyes, as research digs deeper into the chemical behavior of hydrocarbons, the future of petroleum refining takes a new form. There is a vision of no longer having to take what the crude has to offer, marketing the products for what they are worth; but rather the day is approaching when, as a result of knowledge acquired by exercising ingenuity, patience, and diligence, the end products of petroleum processing will have the desired chemical and physical properties, regardless of the type or nature of the crude oil entering the charging lines. The plant no longer merely will refine crude oil, but rather it will, by precise physical and chemical processes, transform crude oil. The past decade has seen tremendous changes in this respect; the next 10 years are unpredictable, but they promise to be fast-moving and interesting.

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